CHAPTER 6

FLOORS AND STAIRS

SECTION I—GENERAL

6.1.1 Types of Floors and Coverings

Floor materials found in buildings and structures for various occupancies include wood, concrete, terrazzo, magnesium oxychloride, clay tile (quarry and ceramic mosaic), mastic, metal, cork, and rubber. Conductive floors are normally peculiar to operating rooms and delivery suites in hospitals and dispensaries. Spark-resistant floors shall be placed in ammunition storage areas, where explosives are stored. Common floor coverings include linoleum, vinyl tile, vinyl-asbestos tile, asphalt tile, cork tile, rubber tile, and resinous coatings for monolithic floors. Floor structures, finishes, and coverings should be suitable for the operations conducted on them. All components should be maintained in such a manner that the complete floor will give satisfactory service. No operations which might impair the floor structure, covering or finish should be conducted until suitable modifications or protective measures have been undertaken.

6.1.2 Types of Stairs

Maintenance instructions are provided herein for interior and exterior stairs of wood, concrete, terrazzo, metal, and composition materials.

6.1.3 Inspection of Floors, Floor Covering, and Stairs

6.1.3.1 *Floors.* Wood floors should be checked quarterly for loose nails; warped, cupped, or loose boards; raised ends; slivers; cracks; loose knots; raised nails; and water or other damage from improper cleaning, condensation, and wood decay. Concrete floors should be inspected annually for dusting, spalling, cracking, and settling. Terrazzo floors should be inspected annually for loose or broken segments and damage from improper cleaning. Magnesium oxychloride floors should be checked annually for water and other damage from improper cleaning. Clay tile floors should be inspected annually for missing, loose, or broken tiles, open joints, and damage from improper cleaning. Mastic-topped floors should be checked annually for damage from improper cleaning. Conductive floors should be tested for conductivity with an ohmmeter at least quarterly or after repair, and a permanent log should be maintained. Conductive flooring will meet the conductivity requirements of the National Fire Protection Association (NFPA) Standards. Metal floors should be inspected annually for corrosion.

6.1.3.2 *Floor Coverings.* Floor coverings should be checked annually. Asphalt and vinyl tile coverings should be inspected for missing, loose, and broken tiles, or open joints; serious indentations; burns; and damage from improper cleaning. Linoleum and other flexible sheet coverings should be inspected for loose seams, buckling, serious indentations, and damage from improper cleaning.

6.1.3.3 *Stairs.* Interior and exterior stairways should be inspected at least quarterly for adequacy of support and safe condition of components. Stairways should be checked, as appropriate, for cracked, weathered, or rotted wood framing; for settled, cracked, or spalled concrete; and for rusted or loose metal supports or parts or loose nails on wood stairs. Treads should be inspected for loose or broken tread nosing, excessive wear, paint or tread covering deterioration, and loose, eroded, or slippery tread surfaces. Exterior treads should be sloped (or drilled) so as to drain properly. Handrails should be inspected for loose fastening and material deterioration. Newel posts and balusters should be checked for looseness and missing parts.

6.1.4 Custodial Services

Proper and timely custodial care will materially prolong the life of floors and finishes. The Military Custodial Tri-Services Manual (TM 5-609, NAVFAC MO-125, AFP 91-30 and 92-1) provides Commanders at DOD installations with methods of accomplishing custodial services and establishes cleaning standards.

6.1.5 Safe Floor Loads

CAUTION: Do not load floors beyond their designed safe load capacity. Permanent and easily read signs or placecards, conspicuously showing the safe load capacity in lb/ft **2** of the floor, should be placed on each floor of a building. Such posting

is also necessary for slab-on-ground floors in warehouses, equipment shops, etc, when imposed loads on them are likely to exceed the bearing capacity of the underlying soil.

SECTION II—WOOD FLOORS

6.2.1. Wood-Strip and Parquet Floors

Strip flooring is usually of oak, pine, maple, beech, pecan or birch and is generally laid over a wood subfloor. Strip flooring should be of tongue-and-groove material and be blind-nailed. Parquet flooring may be solid block or laminated block in the hardwood species and may be nailed or installed in adhesive on concrete slab, plywood subfloor, or hardwood underlay. For gymnasiums, squash and handball courts, and ballrooms, special application methods are used as specified in guide specifications for military construction and in accordance with the manufacturer's instructions.

6.2.2 Reconditioning

6.2.2.1 *Defects in Wood Floors.* Some of the defects found in wood floors and the causes of these defects are listed below:

a. Wide cracks between strips and at end joints, caused primarily by use of unseasoned wood for floorboards and understructures.

b. Raised flat grain and excessive splintering, caused by oversanding or improper cleaning with excessive water and strongly alkaline soap or other damaging cleaning agents.

c. Irregular holes in floor where upended segments have been torn out during mopping or removed to prevent accidents.

d. Unevenness at joints, caused by inadequate nailing or loosening of nails under heavy traffic during the shrinking period.

e. Wood decay, frequently caused by condensation under the floor.

f. Failure to provide for expansion at room perimeter, causing floor to buckle.

6.2.2.2 *Reconditioning Methods.* Floors that have become appreciably worn, cut, gouged, indented, or stained or that have splintered, loose, or warped strips or planks should be refinished or covered. Pine- or hardwood-strip flooring can be sanded about $^{3}/_{16}$ inch or nails are exposed before replacement or overlaying is needed.

6.2.3 Refinishing

6.2.3.1 *Floor Preparation.* Perform the following corrective work before removing old finish, refinishing, or covering floors:

a. Renail all loose and warping boards.

b. Remove all tacks and set nail heads well below the floor's surface.

c. Scrape or machine-sand all high joints to make them level with adjacent floorboards.

d. Remove and replace boards that are damaged beyond reconditioning.

e. Remove loose splinters and fill all holes and large cracks with crack filler.

f. Remove grease, oil, and other foreign matter.

6.2.3.2 *Refinishing Areas with Worn Finish.* Areas where wood-floor finishes are worn may sometimes be reconditioned as follows:

a. If possible, clean the floor by the drycleaning methods, or use a commercial-type "finish renewer' available from most flooring contractors. Most wood-flooring manufacturers recommend that no water be used on the maintenance of wood floors. However, if scrubbing is necessary, use a mop dampened in all-purpose synthetic detergent solution.

b. Liberally apply a varnish-type sealer that conforms to Federal Specification TT-S-176. Spread or spray it along the grain of the wood.

c. After the sealer has dried completely, buff the floor with a floor-polishing machine, using No.1 steel wool pads. If portions of the floor look lusterless, dry, or dead after the buffing, continue sealing and polishing until the floor surface has a uniform appearance.

d. Apply spirit-type liquid or paste wax. Buff the wax after each application.

6.2.3.3 *Sanding*

a. Equipment. Power-operated sanding machines are the most satisfactory means of preparing wood floors for refinishing. The operator should wear an approved respirator or dust mask while sanding. Abrasive paper, commonly called sandpaper, is made with paper or fabric backing. For machine use, a fabric-backed or fabric-reinforced paper backing is recommended. The mineral cutting agent glued to the face of the paper may be flint (Federal Specification P-P-105), garnet (Federal Specification P-P-121, waterproof), or silicon carbide (Federal Specification P-P-101, waterproof). Cutting surfaces are designated close coat (cutting grits covering the entire face) or open coat (grit covering about half the cutting surface). Open-coat paper is recommended for sanding materials, such as paint and varnish, that tend to clog spaces between the grits. Flint papers are made in 12 grades. Flint (sand) papers having glue

binders must not be stored where they will be subject to oil, moisture, or extreme heat and cold. Old brittle paper can be softened by dampening the backing. The following table (table 64) is a guide to sandpaper selection for floor finishing:

TABLE 6-1: Guide to Sandpaper Selection for Floor Finishing

Grade	*Type*	*Use*
3½	Open	Preliminary removal of stubborn varnish, shellac, floor oil, wax, and deep-penetrating filler compounds. Not to be used for cutting into wood surfaces.
3	Open	Used in place of No.3½ for surfaces of less resistance; is preferred if it does the required work.
2½	Open	Preliminary removal of floor finishes such as shellac, wax, floor oils, alcohol stains, and lacquered surfaces.
2	Close	Use instead of No. 2 and No.2½ open coat where surface permits cutting without gumming. Closed coat should be used in preference to open coat whenever practicable.
1½	Close	Use as a first paper on all new floors.
1	Close	Use as followup for No.2 and No.2½ in all cases.
1	Close	Use the same as No. 1 open coat to provide a smooth floor finish.
½	Close	Use as final finish on most floor work.
1/0 & 2/0	Close	Use as final finish on best hardwood floor work.
3/0 & 4/0	Close	Use for finishing fine woodwork such as furniture and for rubbing down paint and varnish finishes.

b. Procedure. Old varnish, shellac and wax material should be removed from the floor with the proper type of abrasive paper. First, go over the floor twice diagonally with coarse paper, avoiding deep abrasive marks in the wood; then finish with fine paper or steel wool parallel with the grain. See figure 6-1. No attempt should be made to cut wood in the removal operation. Edges that cannot be reached by a sanding machine should be hand-scraped. The floor should then be sealed and waxed as described in paragraph 6.2.3.2. The final sanding for parquet flooring must be with a disk sander. Additional information on floor sanding may be found in the Tri-Services Manual, "Paints and Protective Coatings."

6.2.3.4 Use of volatile Liquids.

a. Safety Precautions. In exceptional cases, when old floor finishes cannot be removed by sanding or scraping with an abrasive, highly volatile liquids may be used. These liquids, as well as those used in floor refinishing, include paint and varnish remover, varnish, liquid paint, and shellac, which have flashpoints as low as 40° F (4.5° C). Refinishing should be done only under expert supervision, with attention to the following precautions:

(1) Use rubber gloves and face masks (respirators) when working with highly volatile liquids, varnish, varnish remover, liquid paint, and shellac.

(2) Remove from the area all personnel not engaged in the work.

(3) Provide all possible natural ventilation.

(4) Disengage the main electric switch for the entire building and work under natural light. If this is not practicable, disconnect all electric appliances in the vicinity, including such equipment as water coolers and soft-drink dispensers, before applying volatile liquids. Do not reconnect the appliances until the liquids have completely dried on the floor.

(5) Shut off the main gas valve for the building. If this is not practicable, extinguish the pilot lights on all gas equipment and do not relight them until the volatile liquids have completely dried.

(6) Prohibit smoking and the use of open flames during application of the liquids and for 1 hour after they have completely dried.

(7) Clean only a small area of floor at a time.

(8) Restrict the amount of liquid on hand to that needed for the immediate operation; immediately return any unused liquid to its proper storage place. Do not use open containers for storage.

(9) Provide covered metal containers for used cleaning rags. Remove the cans before securing the building.

(10) Place the residue from sanding machines in cans, wet it down, and promptly remove the cans from the building.

(11) Notify the fire department before operations are started, and observe any additional pre cautions fire officials may require.

b. Application. Old varnish and paint finishes may be removed from a floor by application of an organic-solvent remover conforming to Federal Specification TT-R-251. The remover is brushed on and allowed to stand until the varnish or paint softens. The old finish is then scraped off with a steel blade scraper or rubbed off with steel wool or excelsior. Oil finishes may be removed by a water solution of trisodium phosphate, washing soda, or commercial cleaner. The liquid is applied to the floor, a small area at a time, allowed to stand for a few minutes, and then scrubbed off with a stiff brush. The floor should be scrubbed and mopped to a dry or slightly damp surface. Old shellac may be removed by the use of steel wool saturated with turpentine.

6.2.4 Replacement of Wood Floors

6.2.4.1 *Preparation.* Before laying finished wood floors, inspect wood subfloors, replace defective or otherwise damaged boards, and renail boards that do not have a firm, tight bearing. Broom-clean subfloors of plaster, dirt and other foreign matter. When the subfloor is judged to be clean and dry, put down a layer of asphalt-saturated felt conforming to Federal Specification HH-R-595. Lap edges and ends of felt 4 to 6 inches and turn up under baseboard not less than 3 inches. Finished flooring will not be brought into building until plaster and masonry is thoroughly dry.

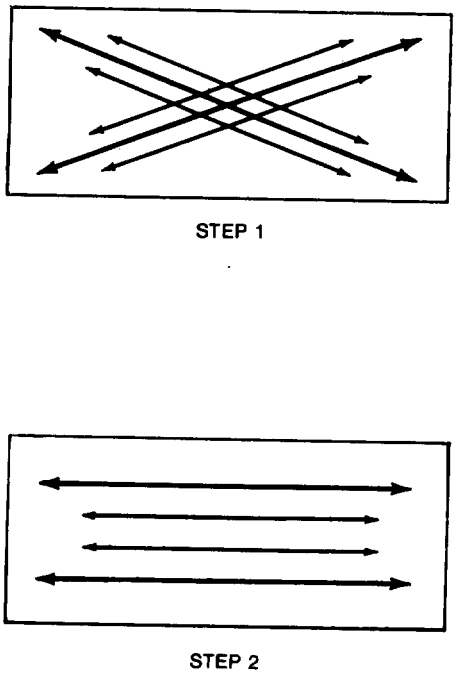

Figure 6-1. PROCEDURE IN SANDING FLOORS

6.2.4.2 *Laying Wood Flooring.* Cut all boards to eliminate knotholes, loose knots, and damaged portions. Blind nail all dressed and matched flooring with straight shank cut steel, or spiral or screw-type shank flooring nails. For 25/32-inch flooring use eightpenny nails. For face nailing, use 8-d finishing nails and set the heads. Normally, flooring should be laid perpendicular to the joists. Nails should extend through the subfloor into the joist. Strip flooring overlying existing strip flooring should be laid perpendicular to the existing flooring. The first strip along the wall must be straight and parallel to walls for it affects direction of succeeding strips. Drive each strip tight against previously laid strip before nailing. End-matched joints may be made random. Make square end joints occur over bearings. Stagger all end joints so there are at least two continuous boards on each side of board joints. Set heads of all exposed nails. Leave an expansion space of not less than ½ inch on all sides next to walls, but not wider than will be covered by the base shoe, quarter round, or door

threshold. Finish flooring by machine sanding. Hand scrape around edges and other surfaces not accessible by machine.

6.2.5 Patching Wood Floors

6.2.5.1 *Procedure.* If floor damage requires re placement of strips or planks, the following procedure should be observed:

a. Make two longitudinal cuts in the damaged strip or plank. See figure 6-2, detail A.

b. Remove the section between the two cuts by cutting the strip with a chisel at midpoint. See figure 6-2, detail B.

c. Remove the remainder of the damaged strip, taking care not to damage the tongues and grooves of adjoining boards. See figure 6-2, detail C.

d. Remove the lower part of the groove of the new closure strip or plank. See figure 6-2, detail E.

e. Insert the tongue of the closure into the groove of the adjoining board for face nail with two eightpenny, annular-ring finishing nails. When possible, the end joints should be located so the nails will enter the joist. In new closure areas of flooring laid in mastic on concrete, remove the existing mastic and apply new mastic of the type recommended by the flooring manufacturer before installing the new closure.

f. Set exposed nails. See figure 6-2, detail D.

g. Dress the new portion to the level of the adjacent floor by sanding both areas to a continuous, smooth plane.

h. Dry-sweep the area to remove all particles of dust.

i. On open-grained woods, brush on a paste filler conforming to Federal Specification TT-F-336. After the filler has partially dried, rub it into the pores of the wood with a circular motion using excelsior or burlap. Wipe the surface lightly to remove any surplus filler. Inadequate filling is indicated by pockmarks and results from wiping off too much of the filler or from unusual absorption by the wood. Eliminate such deficiencies by repeating the filler application.

j. Seal and wax the floors as described in paragraphs 6.2.3.2 and 6.2.3.3 or finish to match existing.

6.2.6 Creaking Floors

Creaking in an old floor may be the result of one or more causes such as shrinking or warping of the boards, insufficient initial nailing, loosening of the subfloor, warping of joints, or the presence of building settlement which throws the floor out of level. If the boards have lifted from the joists, place a wood block on the loose spot and drive down with a heavy hammer or maul. A piece of old carpet or other material placed under the block will prevent marring the finished floor. If floor will not stay down, drive several nails through both finish and subfloor into the joists to draw the floor down tight. Drive nails heads to within ¼ inch of floor, then finish driving and set with nail set. Fill holes over nail heads with putty or plastic wood, colored to match floor finish.

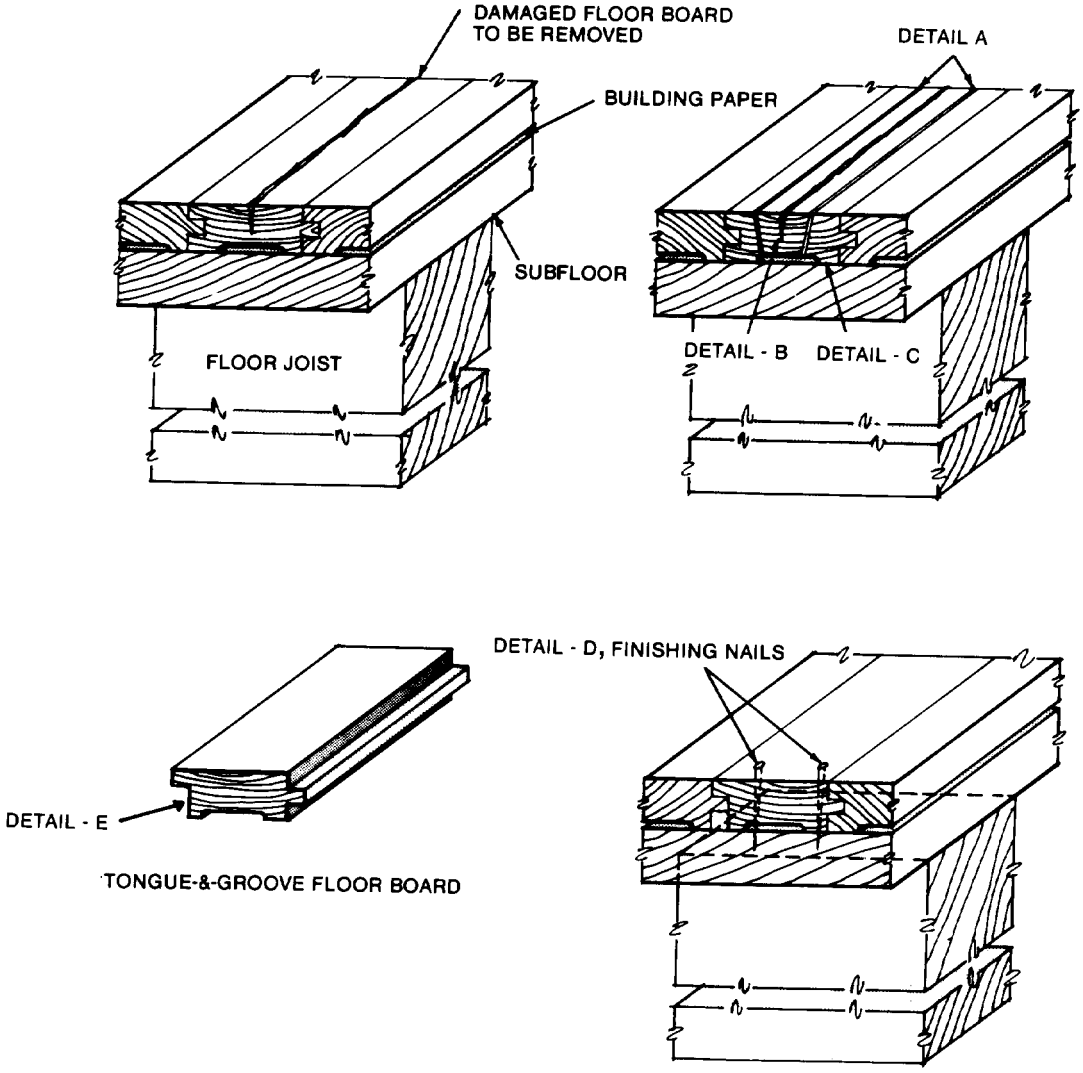

Figure 6–2. METHOD OF REPLACING TONGUE-AND-GROOVE FLOORING.

6.2.7 Preparation for Rug or Carpet Covering

Wood floors that are to be covered with rugs must be sealed to prevent damage from dust that seeps through the covering. Refer to paragraph 6.2.3.2, reconditioning areas with smooth finish, except omit wax coat. Provide padding or underlays to protect rugs from dust seepage and to prolong rug life.

6.2.8 Overlaying of Wood Floors with Resilient Flooring

When wood floors can no longer be resanded and it is not desirable to replace them, they may be overlaid with resilient flooring. Procedures for the overlaying of wood floors with resilient flooring are outlined in Section 6.9, Resilient Floor Covering.

6.2.9 Industrial Wood-Block Floors

6.2.9.1 *Description.* Wood-block flooring is usually of southern yellow pine, oak, western larch, western hemlock, and Douglas fir. Wood-block flooring should be pressure treated with preservative. It usually shows all end grain on the wearing surface. Blocks are made in sizes ranging from 1½ to 4 inches wide, from 3½ to 8½ inches long, and from 2 to 4 inches thick. Grooves are usually cut into the sides and ends of individual blocks, or the vertical corner surfaces are beveled to permit easy penetration of binder into the joints surrounding each block. Blocks are usually laid individually in an adhesive mastic and the joints filled; however, factory-assembled strips of blocks laid in mastic may be used.

6.2.9.2 *Maintenance.* Sweeping wood-block floors with a stiff bristle broom or a power sweeper should keep them dirt-free. In areas where accumulation of dirt and oils requires more than normal sweeping, the floor may be scraped with a metal scraper or cleaned with a power buffing machine equipped with a wire-bristle brush or coarse steel wool pads. Oil or water spills should be removed immediately and the area covered with an oil- and water-absorbing compound conforming to Federal Specification P-S-865. The compound should be swept up after it has absorbed the oil or water. Do not use water on wood-block flooring. Water enters the pores of the blocks or the cracks between them and causes the floor to warp or buckle.

6.2.9.3 *Repair*. Wood-block floors are generally repaired by replacement of splintered, cracked, and loose blocks with new blocks, matching the original materials as closely as possible. Methods of repairing floors are as follows:

a. *Large Areas.* When large areas or the entire floor surface must be replaced, the new floor should be installed according to specifications for the original floor. If the materials originally specified cannot be obtained, they should be matched as closely as possible, and the manufacturer's recommendations followed. Both coal-tar pitch and asphalt products are used in the installation and treatment of industrial wood-block floors. Materials of the respective types used in the original installation should be used for replacement. Coal-tar pitch and asphalt are not compatible and must not be in contact with each other. Test existing materials to determine their composition. Concrete may be used to replace large areas of deteriorated blocks where operational conditions permit and where the weight of the concrete will not exceed the design limitations of the structure. Concrete provides the hardness and toughness necessary to resist heavy loadings but does not provide the resiliency needed for foot comfort or for protection of tools or parts that may be dropped. Repair woodblock floors with concrete as follows:

(1) Lay out the area to be repaired in rectangular lines and include all defective and loose blocks.

(2) Remove all blocks within the rectangular area.

(3) Clean the subfloor of all loose particles, dust, oils, and grease.

(4) Proportion, place, and finish the new concrete as described in paragraph 6.3.4.

(5) Replace all expansion joints and install new expansion joints in the concrete every 20 feet in both directions.

b. *Small Areas.* Small areas of wood-block floors are repaired by replacement of deteriorated or loose blocks with small blocks, matching existing materials as closely as possible.

(1) Remove all deteriorated and loose blocks in the area.

(2) Thoroughly clean the subfloor, removing all loose particles, dust, oil, and grease.

(3) Be certain that the subfloor and surrounding blocks are thoroughly dry. Then, apply one coat of the floor manufacturer's recommended primer to the subfloor and sides of the surrounding wood blocks.

(4) When the primer is thoroughly dry, apply a coat of coal-tar pitch or plastic bituminous cement, as suitable to the subfloor in the quantities necessary for permanent adhesion between the subfloor and wood blocks.

(5) Fit the individual blocks or strips of blocks into place, matching the existing floor lines as closely as possible. Fill any voids of less than one full block with a section of a block cut to fit. Retain existing expansion joints.

(6) Fill the joints and finish or seal the floor, as necessary, according to the manufacturer's recommendations.

SECTION III—CONCRETE FLOORS

6.3.1 Maintenance

Concrete floors of proper composition, installation, and curing require comparatively little maintenance unless they are exposed to the following: severe abrasion and heavy vehicle loads from industrial traffic; the deteriorating effects of grease, oils, and food acids such as are encountered in kitchens, sculleries, bakeries, meat-cutting plants, and similar food preparation spaces; or caustic soaps and solutions. The corrosive agents in highly acidic or alkaline liquids attack concrete floors and cause spalling, pitting and other deterioration; such floors may be overlaid with resinous (epoxy, polyester) industrial (tru-welded-on) type topping or with resinous terra 330. When trucking is done over concrete floors, as in aisles of warehouses, trucks should be fitted with wide-faced wheels with rubber tires. If vehicle abrasion and shock continue to raise maintenance demands, the application of heavy-duty topping to the concrete should be considered. CAUTION: Avoid painting concrete floors except for functional requirements, such as marking safety

lanes or similar areas. Painting for appearance is unjustified and impractical. Traffic areas on painted floors will wear first, making the floor unsightly and presenting a difficult cleaning problem. Cost of repainting constitutes an unnecessary expenditure of maintenance funds. Much useful information on concrete floors can be found in publications by and available from the Portland Cement Association and in the "Concrete Manual" published by and available from the Bureau of Reclamation, U.S. Department of the Interior. Also refer to pavement manuals.

6.3.2 Repairs

Concrete floors should not be repaired until causes of defects have been determined and preventable causes have been eliminated.

6.3.2.1 *Cracks.*

a. Causes and Corrections. Cracks in concrete floors may be caused by shrinkage, expansion or contraction due to temperature changes, settlement, or lack of rigidity of supporting beams or other structural members. When such movements are recurrent and can be eliminated only by major structural changes, little can be done except to keep the cracks filled with a mastic material. In many cases, comparatively small cracks may be filled with varnish or resin. Although the cracks will remain visible, they will not leak or gather dirt. When the cause of large cracks has been determined and corrective measures taken to eliminate further cracking, the cracks can be permanently repaired by filling them with nonshrinking cement mortar. Patching will not permanently correct cracks in slabs on grade caused by vertical movement resulting from exceeding the design load of the slab, inadequacy of the base, or insufficient bearing capacity of the soil. Slab failure under these circumstances may sometimes be corrected by mud jacking. Following completion of mud jacking, cracks should be cleaned and filled with an epoxy resin preparation, which should be used only in accordance with the manufacturer's recommendations. Complete replacement of slab-on grade floors is often the only feasible method of repair.

b. Procedure for Repairing. Chip or rout out cracks to be repaired. Form a channel of at least 1 inch deep, with vertical sides. If the crack extends through the structural slab, cut a V-shaped groove, at least 2 inches deep, in the bottom of the channel, resulting in a total depth of 3 inches. If the crack does not extend through the base and if the top course is less than 3 inches thick, chip the V-shaped groove only to the depth of the wearing course. Clean out all loose material with a stiff brush and compressed air. First saturate the area to be patched and the adjoining surface with water. Keep them wet for at least 4 hours. Mop up the excess water. Spread a thin layer of neat port land cement on the sides and bottom of the crack. Broom the cement into the surface of the concrete. As soon as the cement has absorbed enough water to form a sticky paste, place the new mortar. Tamp the mix into the crack and with a screed, bring it to a level slightly higher than the adjoining floor. Let it set for about 1 hour. Tamp it hard and trowel it to the level of the adjoining floor. Keep the new concrete wet and protect it from traffic for about 7 days (3 days if high early strength is used).

6.3.2.2 *Patches.*

a. Preparation. Lay out patches in rectangular lines to include all defective surfaces. The edges of the areas to be patched should be saw cut. Chip out the old concrete to a depth of at least 1 inch or until sound concrete is reached. Roughen the chipped surfaces and provide vertical sides. Clean out all the loose particles and dust. Saturate the prepared areas and adjoining surface with water and keep them wet for at least 4 hours. Remove any pools of water that may accumulate on the roughened area, neatly spread a layer of portland cement uniformly, and thoroughly broom it into the surface. As soon as the cement has absorbed enough water to form a sticky paste, apply the patching mixture.

b. Patching Prepare a patching mixture consisting of 1 part portland cement, 1 part well-graded sand, and 2 parts pea gravel or crushed rock, graded from **c** to **d** inch. Mix the dry ingredients of the concrete thoroughly. Use no more than 4½ gallons of mixing water for each sack of cement. Continue the mixing for at least 1½ minutes after all the ingredients, including water, are in the mixture. The concrete, after being placed on the slab, should be vibrated, rolled, or tamped in place. Screed to proper level and float. Steel trowel to a hard finish. Cover the new concrete with wet burlap or another approved method (spray paint), protect it from traffic, and keep it wet for 7 days (3 days if high-early strength cement is used).

6.3.3 Refinishing by Grinding

Improperly constructed floors that have topping finish may be roughened by traffic or pitted by heavy impacts. Such floors can be restored to satisfactory condition by grinding off the roughened surface. If the concrete is of such poor quality that the surface will soon be roughened or pitted again,it would be more economical to resurface or

replace it with concrete of the proper quality. Concrete surfaces often have numerous hairline cracks and crazes as a result of improper curing. If the cracks are not too deep, they may be eliminated by grinding the floor. Concrete floor surfaces are ground by the method used in finishing terrazzo floors, which requires highly skilled labor under adequate supervision.

6.3.4 Resurfacing

6.3.4.1 *Suitability of Floors.* Wearing surfaces of concrete floors that are spalling or abrade easily under foot traffic should be resurfaced or covered. Old floors that have been subjected to service too severe for the quality of the surface can be resurfaced with a heavy-duty topping. If the floor design load permits and if raising the floor level is not objectionable, a new topping can be placed directly on the old slab.

6.3.4.2 *Preparation.* All dust, paint, grease, oil, and loose materials should be cleaned from the old floor before it is resurfaced. Areas that have the original troweled finish should be roughened with a pick or grinding tool. Expansion and construction joints should be retained. Whenever practicable, the new topping should be at least 2 inches thick and reinforced with 2- by 2-mesh galvanized welded wire fabric, 21 pounds per 100 square feet, placed approximately in the middle of the thickness of the new concrete.

6.3.4.3 *Concrete Mixture.* New concrete should consist, by volume, of 1 part portland cement, 1 part graded sand, and 2 parts pea gravel or crushed rock, graded from **c** to **d** inch. It should be of the stiffest consistency practicable so that the strike-off board or straightedge may be used in a sawing motion. Not more than 4 gallons of mixing water, including the moisture in the aggregates, should be added for each sack of portland cement. Use not more than 5 gallons when floating is done by hand. The concrete should be mixed for at least 1½ minutes after all ingredients, including the water, are in the mixer.

6.3.4.4 *Application of Finish.* Keep the base slab thoroughly moist for a 24-hour period before placing the finish, but allow no pools of water to remain when the wearing course is placed. Broom a thick coat of neat cement grout into the surface of the slab for a short distance ahead of the topping. Before the grout has hardened, place the wearing course and bring it to the established grade with a straightedge. Compact the wearing course by rolling with weighted rollers or tamping with iron tampers. Float the surface with a wood float or power-floating machine, making sure no water remains on the finished surface. Test the surface a with straightedge to detect high and low spots and eliminate them. Finish the surface with a steel trowel. Allow the concrete to become hard enough that mortar will not accumulate on the trowel. In the final troweling, a ringing should be produced as the trowel is drawn over the surface. Do not sprinkle dry cement or a mixture of dry cement and sand on the wearing course to absorb moisture or stiffen the mix. This will make the surface weak and produce cracks and crazes. Cover the concrete with wet burlap as soon as it has hardened enough not to be damaged by the covering, and keep it wet for at least 7 days.

6.3.5 Heavy-Duty Floors

Concrete floors in receiving rooms, loading platforms, and other locations that are subjected to impact from falling objects, heavily loaded steel-tired trucks, or sliding loads usually require protection, such as steel floor grilles or surface treatment.

6.3.5.1 *Grilles.* Steel floor grilles are set in concrete, with openings between the grilles filled with concrete. Grilles should be installed according to the manufacturer's recommendations. The top surfaces of the grilles should be level with the finished floor.

6.3.5.2 *Surface Treatment.* Metallic monolithic surface treatment consists of a factory-prepared mixture containing iron aggregate, suitable for application as a part of a new concrete topping by the dusted-on method. The mixture should be free from nonferrous metal particles, oil, grease, and soluble alkaline compounds. It should be water-absorbent and contain not more than 0.075 percent of water-soluble material. A cement-dispersing agent and a pozzolanic material that will combine with free lime to form a water-insoluble compound should be combined with the metallic aggregate. In applying the finish to the topping, strike off the topping true and screed it to the finished elevation. Apply the dry mixture over the freshly screeded concrete at a uniform rate of 60 pounds per 100 square feet of surface. After the mixture has absorbed water to a uniform appearance, rod it with a straightedge to a uniformly true surface. When absorption is complete, compact the finish by rolling with heavy rollers or by floating with motor-driven floats of the metal disk type. Add material to low spots until a uniform appearance is obtained. Follow the compaction with troweling by hand or machine to produce a smooth, hard, and impervious surface. Cure heavy-duty floors as recommended in paragraph 6.3.4.4.

6.3.6 Nonslip Floors

A nonslip floor is required in certain areas. In resurfacing floors in such areas, nonslip aggregates may be mixed with the concrete or sprinkled on the surface of the wearing course just before final troweling. More aggregate is required when it is mixed with the concrete, but distribution on the aggregate is usually more uniform. Nonslip aggregates should be particles of aluminum oxide, emery ore, or ceramically bonded abrasive, such as Carborundum, ranging in size from $^{1}/_{32}$ to ¼ inch. If mixed with the concrete, ¾ to 1 pound of aggregate is required for 1 square foot of floor when topping is ¾ to 1 inch thick. If sprinkled on the surface, ¼ to ½ pound of aggregate is required for 1 square foot of floor. To apply the aggregate directly to the floor, dampen the abrasive aggregate thoroughly before spreading, and tamp it flush with the unhardened surface with a steel trowel. Be careful not to bury the chips. Cure the floor as recommended in paragraph 6.3.4.4. After curing, scrub the floor with a floor machine, using steel wool pad (or rub it with an abrasive brick and water) to remove cement film and slightly expose the nonslip aggregate.

6.3.7 Waterproofing

6.3.7.1 *Causes of Seepage and Damage.* Concrete floors that must resist the percolation of water applied on the upper surface are usually waterproofed during construction. Improper waterproofing or building settlement may require remedial action. Floors usually leak at the line where the floor joins the wall, through cracks that may be very small, and through porous concrete. If the surface of a concrete floor can be raised, the floor can be waterproofed with a bituminous membrane waterproofing.

6.3.7.2 *Waterproofing Methods.* Application of bituminous membrane waterproofing (felt and coal-tar pitch or asphalt) is similar for concrete floors and masonry walls. If coal-tar pitch is used, coat the concrete base uniformly with hot pitch conforming to Federal Specification R-P-381, Type II (also ASTM D-450). Use not less than 40 pounds per 100 square feet, and lay over this two or four layers (depending on extent of leakage and hydrostatic pressure) of coal-tar pitch-saturated felt conforming to either ASTM D-173 cotton-fabric felt, or ASTM D-1327 burlap-fabric felt, or ASTM D--1668 glass-fabric felt. Lap each layer 24½ inches for 36-inch-wide material (22 inches for 32-inch material) over the preceding layer, and make endlaps not less than 6 inches. Mop hot coal-tar pitch at the rate of 25 pounds per 200 square feet for the full 241/2 inches on each sheet, so that the felt does not touch felt in any place. Mop the top surface of the top layer with hot pitch at the rate of 25 pounds per 100 square feet. As far as practicable, extend the waterproofing up vertical surfaces not less than 8 inches. If asphalt felts and moppings are used, coat the concrete with asphalt primer conforming to Federal Specifications SS-A-701, at the rate of 1 gallon of primer per 100 square feet. Allow primer to dry and then apply hot asphalt at the rate of 30 pounds per 100 square feet. Lay either two or four layers of asphalt-saturated felt conforming to Federal Specification HH-R-590, Type I (also ASTM D-173 cotton-fabric felt, ASTM D-1327 burlap-fabric felt, ASTM D-1668 glass-fabric felt), as recommended for coal-tar pitch felts except that moppings should be at the rate of 20 pounds per 100 square feet, using asphalt that conforms to Federal Specification SS-A-666.

6.3.7.3 *Concrete Topping over Waterproofing* When bituminous-membrane waterproofing is applied, a 3-inch concrete topping should be provided over the waterproofing. A 2-inch concrete topping should be provided over metallic-type waterproofing. Topping should be applied as recommended for resurfacing in paragraph 6.3.4. Extreme care should be exercised to prevent damage to the waterproofing membrane.

6.3.8 Surface Treatment

6.3.8.1 *Selection.* The application of a surface treatment that tends to increase the density and protect the wearing surfaces of concrete is usually desirable. The selection of the surface treatment should be governed by the nature of the operations normally conducted on the floor. The selection, preparation, and application of surface treatments are covered in detail in paragraph 2.2.13 of this manual.

6.3.9 Reconditioning Concrete Floors to Receive Coverings

6.3.9.1 *General.* Coverings are primarily used on faulty wood floors. However, occasions may arise when it is necessary to lay coverings over new or old concrete floors. In such cases, the following procedures are recommended.

6.3.9.2 *Preparation of Concrete Floors.* To be suitable for covering, concrete floor surfaces must be smooth, fully cured, dry and free of oil, grease, dirt, lime coating, and other substances that will prevent proper bonding between floor and covering. Score with a wire brush. A single coat of paint that is dry and well bonded to the concrete may be removed. Where there are two or more coats of paint, varnish or other finishes, or where there is

scaling and looseness, remove all coats by one or more of the methods described for cleaning wood floors.

6.3.9.3 *Roughness.* Old concrete floors that are rough, spalled, rutted, cracked, or in otherwise unsatisfactory condition, must be repaired before laying a flexible floor covering. Frequent repairs or replacements are necessary when coverings are laid over deteriorated floors, especially those subjected to wheeled traffic. Use complete concrete patches, cement grout, quick-set patching cement, crack filler, or other suitable materials and methods, to obtain a smooth surface. See chapter 2 for details on concrete-slab repairs. If the concrete floor is in such condition that patching is impracticable, a trowel-on type of underlay should be installed.

6.3.9.4 *Alkalinity.* Concrete floors are usually alkaline and may be coated with free lime. This can be detected by applying a 1-percent solution of phenolphthalein in alcohol (obtainable at any drugstore) to the concrete surface. Dampen several spots on the concrete with water and apply a few scattered drops of the phenophthalein. If the concrete is alkaline, the drops will turn red or purple. Test the suspected floor at several points. Floors shown to be alkaline and floors on which strong caustics or alkali solutions have been used to remove paint, varnish and similar materials are neutralized by washing with a 10-percent solution of muriatic acid and water. Rinse the floor to remove acid and lime. Allow enough time to dry thoroughly before applying the covering cement.

6.3.9.5 *Dampness.* All types of flexible floor covering can be laid over suspended concrete floors which have underfloor ventilation. Allow sufficient time (2 or 3 months may be required, depending on the weather) for a new floor to dry before covering is applied. Open windows for natural ventilation during daytime, but close them at night to shut out damp air. Concrete with a hand-troweled surface treated with a hardener also dries slowly. If boxes, mats, or other objects with large flat-bottom surfaces have been on the concrete floor for a long time, they should be moved and the area inspected for wet spots, which indicate that moisture may be coming up through the concrete. This moisture is usually not seen on exposed areas because it evaporates as fast as it reaches the surface. When dryness of floors is in doubt, one or more of the following tests should be performed:

a. Flat Sheet Test. Place pieces of flat glass, rubber, or other waterproof sheets at several points on the floor. Remove the covering after about 24 hours. It may be assumed that the floor is dry if no moisture shows on the concrete. If moisture shows, allow additional time and apply heat and ventilation to assist in drying.

b. Putty Ring Test. Form rings of putty about 6 inches in diameter and ½ inch high at several points on the concrete. Inside each ring drill one or two ¼- to ½-inch-diameter holes about 1 inch deep. These holes will allow any moisture in the slab to escape. Place a level teaspoonful of granulated, anhydrous calcium chloride in a small dish in each putty ring and cover with a piece of flat glass, pressing the glass down on the putty to keep out all outside air. If the floor is damp, beads of moisture will appear on the glass cover in 24 to 48 hours and the calcium chloride will be partly or completely dissolved. If dampness is noticeable, repeat the test at weekly intervals until the calcium chloride does not dissolve.

c. Adhesive Patch Test. Spread patches of adhesive about 2 inches square in each corner and at several spots elsewhere on the floor. After 24 hours, test the adherence of adhesive with a putty knife. If the adhesive peals off, moisture is rising too rapidly for a satisfactory installation of any cemented-on covering. Allow additional time for drying.

6.3.9.6 *Preparation of Floor for Rug or Carpet Coverings.* Concrete floors that are to be covered with carpets or rugs should be sealed to prevent damage from the dust that seeps through the coverings. Prepare the floor by the following process:

a. Thoroughly clean the floor, exposing the true wearing surface so as to disclose any defects. Patch honeycombed areas and fill cracks with mastic.

b. Apply proper surface treatment as described under the applicable portions of paragraph 2.2.13.

c. If nailing strips for fastening the carpet to the floor were not installed when the floor was constructed, provide suitable fasteners in the concrete surface.

SECTION IV—TERRAZZO FLOORS

6.4.1 General

Terrazzo traditionally has been a form of mosaic flooring made by embedding small pieces of marble in mortar and polishing. Today, this traditional material is obtained by combining selected marble chips in a matrix of portland cement or, more recently, in synthetics or resinous matrices.

6.4.1.1 *Cementitious Terrazzo.* Generally, cementitious terrazzo is a mixture of marble chips and portland cement. These terrazzo floors are usually

laid on concrete slabs and may or may not be bonded directly to the concrete. When structural movement or vibration is anticipated, a "floating" terrazzo floor is usually installed. The concrete slab is overlaid with a layer of sand, which is covered with a waterproof membrane such as bituminous felt, and a cement mortar underbed is installed on the felt. The finished terrazzo surface, **e** to ¾ inch thick, is then laid over the underbed. The total thickness of underbed and terrazzo surface is usually 2 to 3 inches. To guard against further cracking, terrazzo areas are limited to 4 by 4 feet, with dividing strips of nonferrous metal set in the mortar bed and extending to floor level. Terrazzo floors may be bonded to the concrete without sand or felt between or may be integral with the prepared slab.

6.4.1.2 *Installation of Topping* After the underbed has hardened sufficiently, the terrazzo is laid and then compacted with heavy rollers. The wearing surface is ground and polished after it has hardened.

6.4.1.3 *Resinous (Thin-Set Terrazzo).* This noncementitious type of surface is made by embedding marble chips in a matrix of resin such as epoxy, polyester, latex, or polyacrylate. Latex terrazzo may be as thin as **d** inch while the others may be as thin as ¼ inch.

6.4.2 Cleaning New Floors

Terrazzo appears to be dense and very hard, but the cement is sensitive to harsh soaps and cleaners, which can cause the floor to be pitted, rough, and permanently susceptible to dusting and trapping of dirt. Sweeping compounds containing oil will penetrate and permanently discolor terrazzo. Newly installed floors should be scrubbed with a synthetic detergent cleaner two or three times a week and mopped on alternate days. The floor should be rinsed thoroughly after each washing. After 2 or 3 months of this treatment, the floor will acquire a natural sheen and require only routine maintenance, including the regular application of a sealer. Sealing of new terrazzo prolongs the slow-drying process of the cement, making the floor denser and assuring longer life. The use of a sealer on old terrazzo retards the penetration of stain-carrying water into the marble and cement mixture. Sealing also prevents dusting and blooming.

6.4.3 Discoloration of Terrazzo

When areas of a terrazzo floor become yellow while adjacent slabs retain their original color, the discoloration is generally due to the way the floor was originally finished. Poulticing with grit scrubbing powders will remove most discoloration caused by improper finishing. The powders should be stirred slowly into a pail of hot water until a thick paste of mortar consistency is obtained. Discoloration can also be removed by scrubbing the surface with Javell water. Javell water is a strong bleaching material and should not be used for general-purpose cleaning. If not available from stock, Javell water may be prepared and applied to the floor as follows: Dissolve 3 pounds of washing soda in 1 gallon of water. Mix 12 ounces of chlorinated lime and water to a paste in a shallow, enameled pan, adding the water slowly and mashing the lumps. Add the paste to the soda solution making a maximum of 2 gallons by adding water, and place the mixture in a covered stoneware jar to settle. Use the clear liquid, diluting it with six times its volume of clear water. Rinse the surface with clear water and then use the Javell water as a soap or scrubbing solution.

6.4.4 Repairs

Repairs to a terrazzo floor should be made in accordance with the specification for new floors. Only floor specialists who are capable of the class of workmanship necessary should be entrusted with the work.

SECTION V—MAGNESIUM OXYCHLORIDE FLOORS

6.5.1 Installation and Repairs

Experienced personnel are essential in installing and repairing magnesium-oxychloride (often called Magnesite) flooring and the manufacturer's recommendations should be followed closely. Floor failures are usually caused by improper installation or use. This type of floor is not recommended for kitchens, bakeries, warehouses, and other buildings where floors are subject to spillage of food, oil, grease, and considerable amounts of water or areas subject to the abrasive and shock action of truck wheels. If magnesium-oxychloride floors are mopped dry after each wetting, they will withstand daily scrubbing. The flooring can be installed over prepared wood and concrete floors in thickness of ¾ inch or more as conditions require. It should never be applied over asphalt tile, linoleum, cork, rubber, or other flexible coverings.

6.5.1.1 *Specifications.* The following table lists specifications prepared by the American National Standards Institute Association. See table 6-2. They are offered as a guide to the many

requirements that must be observed in mixing and laying oxychloride-type flooring.

Table 6-2. — Specifications Prepared By American Standards Institute Association.

ANSI designations	Title
A88. 1	Preparation of subfloors for Oxychloride-Composition Flooring.
A88.2	General Purpose, Oxychloride-Composition Flooring and Its Installation.
A88.3	Heavy Duty, Oxychloride-Composition Flooring and Its Installation.
A88.4	Basecoat, Oxychloride-Composition Flooring.
A88.5	Nonslip, Oxychloride-Composition Flooring and Its Installation.
A88.6	Terrazzo, Oxychloride-Composition Flooring and Its Installation.
A88.7	Industrial Granolithic, Oxychloride-Composition Flooring and Its Installation.
A88.8	Oxycement Underlay and Its Installation.

6.5.1.2 *General-Purpose Type (A 88.2).* General-purpose type, most commonly used, is usually mixed and laid in a solid color through the full thickness of about ½ inch. This general-purpose flooring, when troweled to a dense, smooth, semiglossy wearing surface, results in a floor with a wearing hardness only slightly less than that of Tennessee pink marble.

6.5.1.3 *Heavy Duty (A 88.3).* Hard, coarse aggregates give a wearing surface suitable for heavier service required in light industrial plants and other areas subjected to hard usage. This flooring is generally laid to a thickness of not less than ½ inch.

6.5.1.4 *Industrial Granolithic (A 88.7).* This is a terrazzo type since the aggregate is crushed granite, trap rock or similar hard stone chips. This floor, usually laid to a thickness of ¾ inch, is finished by mechanical grinding but not such as will produce a polished surface. The finished floor is extremely tough and durable and will meet the demands of extra hard usage.

6.5.1.5 *Nonslip (A 88.5).* This flooring is furnished in two types: Type I, General Purpose Nonslip, and Type II, Heavy Duty Nonslip. Crushed rock is re placed in part with an abrasive aggregate to produce a nonslip surface. Other types of oxychloride flooring may be made nonslip by use of abrasive materials in the wearing surface.

6.5.1.6 *Terrazzo (A 88.6)* Oxychloride terrazzo is produced by the use of marble or other chips of varying size and color and a matrix of contrasting color.

6.5.1.7 *Preparation of Subfloors (A 88.1).* This specification describes the preparation of new and old concrete, wood, brick, stone, metal and ceramic tile subfloors prior to the application of an oxychloride floor.

6.5.2 Materials

Refer to manufacturer's standard specification for information relative to dry-mix compositions, aggregates, gaging solutions, water, metal anchoring mediums, liquid bonding mediums, division strips, and other components necessary to insure a proper cementitious flooring installation.

6.5.3 Miscellaneous Requirements

6.5.3.1 *Preparation.* Prior to the start of any flooring operations, all pipe rails, radiators, space heaters, water coolers, and other items of equipment that will interfere with the installation of the floor should be disconnected and removed from the work area. Check the present floor framing to see that it is of such design, structural strength, and rigidity to withstand, without appreciable deflection or movement, the maximum service to which the finished floor will be subjected. When resetting the removed equipment, necessary provision must be made in all connections to accommodate the increased thickness of the new flooring.

6.5.3.2 *Insulation.* All new and existing pipes which will pass through the floor should be separated from the flooring by being wrapped with at least two turns of asphalt-saturated felt leaving sufficient clearance to permit free movement of the pipe. Trim the insulating felt flush with the finished flooring. Retard the possible passage of smoke or fumes by loosely packing the space be tween flooring and pipe with glass wool, rock wool or other fire-resistant material. Metal surfaces, such as knothole covers, which will be in contact with the composition flooring should be given a coating of bituminous paint.

6.5.3.3 *Fitting Doors.* Doors which swing over the new flooring should be removed and sufficient material cut from the bottom edge to provide about ¼-inch clearance. The cut edges should be given a coat of spar varnish or paint before the doors are rehung.

6.5.3.4 *Thresholds.* Thresholds of hardwood should be provided at all interior and exterior doors. Thresholds will have a vertical surface abutting the new flooring and a 30° bevel on the exterior.

6.5.3.5 *Temperature.* In areas where composition flooring is to be laid, the room temperature should not exceed 95° F (35° C) until final set is attained. The temperature at time of installation should be maintained substantially uniform and should not decrease more than 20° F (-6.7° C) for at least 24 hours after completion of the floor. Composition floorings should not be laid when the work-area temperature is less than 50° F (10° C). Heating should not be accomplished by means of salamanders. Warm air should not be blown across freshly laid composition flooring. During the installation and curing period, doors and windows to the work area should be kept closed or so arranged as to prevent harmful circulation of air.

6.5.3.6 *Additional Requirements.* Check the manufacturer's standard specification relative to the floor to be laid for additional installation requirements.

6.5.4 Preparation of Surfaces

Subfloors of both wood and concrete should be dry and thoroughly cleaned free of mud, grease, wax, plaster, paint, asphalt and any other foreign sub stances.

6.5.4.1 *Concrete Subfloors.* The term concrete includes lightweight concrete, cinder concrete, and concrete fill or grout. The surface glaze should be completely removed by sandblasting, bushhammering, or other manner approved by the installation engineer. In addition to removing the glaze, the floor should be adequately roughened. If a bush-hammer is used, not less than 70 percent of the surface should be roughened, with the hammer marks distributed uniformly. If a pick is used, the pickmarks should be not less than **c** inch deep, not less than 2 inches in diameter, and be evenly spaced at intervals not exceeding 6 inches on centers. Rapid scarifying may be accomplished by use of a power-driven machine equipped with a cylindrical cage fitted with a series of hardened steel cutters. The cutters are mounted to provide a flailing, scoring hammermill action which results in a diagonal or crosslatched pattern in the concrete surface. Cracks in old concrete should be cut out sufficiently to permit removal of loose chips and dust and then grouted flush.

6.5.4.2 *Wood Subfloors.* Place on the cleaned wood floor a covering of 15-pound, asphalt-saturated felt or an equivalent waterproof building paper. Lay the felt or paper free of wrinkles or bulges and with all edges lapped not less than 1 inch. A coating of emulsified asphalt of such consistency that it will not pass through cracks in the wood floor may be used in lieu of the felt of paper. A mechanical anchoring medium consisting of meta lath or metal mesh should be laid over the fel with lapped and wired edges so as to cover completely the surface which is to receive the flooring mix. The anchoring medium should be secured by means of nails and staples, placed about 6 inches apart in two directions. The fastenings should be driven in such a manner that the anchoring medium is nowhere embedded in the felt and Sc that a gage [1/18] inch thick will just fit between the felt and the anchoring medium. Nails should extend through not less than seven-eighths of the wood floor's thickness and in case of a double floor should extend into the lower layer.

6.5.4.3 *Base.* Where wood-stud walls to receive a composition base adjoin an existing wood floor, the felt and metal lath on the floor should be turned up the walls to within ½ inch of the top of the base and be secured by nailing into the studs and backing. Where wood-stud walls to receive composition base adjoin an existing concrete floor, the walls should be covered with a strip of asphalt felt and metal lath to about base height. Bend the strip lath to about base height. Bend the strip lath to lap 2 inches onto the concrete floor and secure with concrete stub nails spaced about 6 inches apart. Secure top edge of metal lath by nailing into the studs and backing.

6.5.4.4 *Flashing* Areas subject to water spillage which are situated on upper floors should be provided with adequate perimeter flashing to prevent leakage to space below.

6.5.4.5 *Installation Procedures.* Refer to manufacturer's standard specifications for information relative to slump test, applied thickness, placing the composition mix, troweling, curing, sealing, and protection.

6.5.5 Cleaning

The finished floor should not be scrubbed or flooded with water for at least 15 days after installation. Where tests for electrical conductivity are required, they should not be made until the floor has completely cured, usually a period of 30 to 60 days. Properly formulated composition floors, when cured and sealed, offer considerable resistance to gasoline, turpentine, animal, mineral and vegetable oils, and greases. However, good housekeeping and safety require speedy removal of these materials when spilled on the floor. The use of a solvent to remove oil and grease usually will not harm the floor though it may remove the easily replaced wax coat.

SECTION VI—CLAY TILE FLOORS

6.6.1 Ceramic Tile

Ceramic tile is glazed or unglazed, manufacture in small squares, hexagonal, rectangular, and circular shapes about 'A inch thick, and is often arranged in mosaic patterns. The pieces are usually factory-assembled on paper sheets in the required pattern, laid on a mortar setting bed, pressed firmly on the mortar, and tamped true and even with the finished floor line. Grout is then force(into the joints, filling them completely, and is finished flush and level with the floor line.

6.6.2 Quarry Tile

Quarry tile is unglazed and manufactured in square and rectangular shapes, ranging from 2-3¾ to 9 inches wide, and 2-¾ to 12 inches long, with varying thicknesses. Tiles are laid individually or a mortar setting bed with joints about ½ inch wide.

6.6.3 Repair of Tile Floors

Replace broken or badly stained tiles and reset loose tiles in the following manner:

6.6.3.1 Remove the damaged or loose tiles.

6.6.3.2 Clean the mortar from the edges of the surrounding tile.

6.6.3.3. Roughen the concrete underbed to provide a good bond for the new setting cement.

6.6.3.4 Dampen the underbed and edges of the surrounding title and place the setting mortar mixed in the proportion of 1 part portland cement to 3 parts sand.

6.6.3.5 Set the tile, tamping it to the level of the finished floor.

6.6.3.6 Fill the joints with grout or pointing mortar, matching the color and finish of the joints of the original floor as closely as practicable. If the mortar in the existing joints has deteriorated, cracked, or crumbled, thoroughly clean the joints of all loose mortar and repoint them with grout or pointing mortar. Grout joints **c** inch or less wide with neat portland cement grout of the consistency of thick cream. Point joints **c** to ¼ inch wide with pointing mortar consisting of 1 part portland cement to 1 part pointing sand. Point joints wider than ¼ inch with pointing mortar consisting of 1 part portland cement to 2 parts pointing sand.

6.6.3.7 In locations such as food preparation areas, where the floor is directly exposed to the effects of corrosion agents, use acid-resistant joint material to fill the joints. The acid-resistant mortars are proprietary products and should be mixed in accordance with the manufacturer's recommendations. They are composed of both powdered and liquid resin cement and should be resistant to the effects of oils, fats, greases, organic and inorganic acids, salts, alkalies, and mineral solvents.

SECTION VII—MASTIC FLOORS

6.7.1 Description and Use

Mastic coatings applied on concrete or rigid wood floors provide a resilient floor finish that is suitable for a variety of uses. Mastic topping, when hard and cured, forms a tough, dustless flooring that is highly resistant to abrasion and shock from vehicles. Neoprene-type coating similar to that used in mothballing equipment can be obtained in a variety of colors and makes an excellent resilient floor finish. The mastic topping should be finished to a thickness of not less than ¼ inch above the highest section of existing floor, with additional thickness as required. Free edges should be feathered.

6.7.2 Preparation of Floor

The concrete floor to be topped should be cleaned of all dust, dirt, and other foreign matter by vigorous sweeping, airblasting (operators must wear safety glasses), or other suitable means. Oil or grease can be removed with a solution of ¼ pound of common household lye or trisodium phosphate dissolved in 1 gallon of hot water. The hot solution should be applied to the greasy surface and allowed to remain for about 10 minutes. Then the area should be scrubbed with a stiff bristle, fiber, or wire brush. The area should be mopped, flushed with clean water, and mopped again. This action should be repeated until all the cleaning compound is removed. Care must be exercised to keep the cleaning compound away from skin and eyes. After the concrete has been cleaned and is still damp, a specially prepared emulsified asphalt primer is applied and allowed to dry to a tacky state. Then, the floor is topped with either cold or hot mastic.

6.7.3 Cold-Laid Mastic

Cold-laid bituminous mastic floors are usually laid in layers. Coatings consist of a fibrous mastic. The mastic material is similar to the primer but is ground with enough asbestos and finely powered

siliceous material fillers to make a very thick, pasty, fibrous mass. When a coating is dry, succeeding thin coats are applied until the desired thickness is obtained. The total thickness of cold-laid mastic floors is usually ¼ to **d** inch.

6.7.4 Hot-Applied Mastic

Hot-applied bituminous mastic floors are similar to the mixtures used in sheet asphaltic pavements, but they contain more asphaltic binder so that they can be troweled into place when heated to a fluid condition. The mastic is usually applied in layers ¾ inch or more thick. The mastics used should be applied according to the manufacturer's recommendations.

SECTION VIII—CONDUCTIVE FLOORS

6.8.1 Description and Use

Conductive floors made of terrazzo or other suitable materials are required to prevent accumulation of electrostatic charges. Conductive floors are used in hospital and dispensary operating and delivery suites where explosive anesthetics are used, in ammunition inspection and manufacturing areas, and in areas where electrical equipment is tested.

6.8.2 Testing

Conductive tests should comply with requirements in the National Fire Protection Association Standard, Recommended Safe Practice for Hospital Operating Rooms, which prescribes the method of installation. The floor should be tested for conductivity immediately before the first use.

6.8.2.1 *Schedule.* The following schedule is recommended for subsequent testing of hospital operating rooms.

a. Test at least once a month.

b. Test after each alteration or repair of the floor.

c. Test after each waxing has dried and again about 24 hours after the waxing.

6.8.2.2 *Conditions.* Make the tests only under the following conditions:

a. When the room is free of explosive gas mixtures.

b. When the floor is completely dry, i.e., at least 4 hours after cleaning or waxing.

c. When the relative humidity of air in the room is the same, or as close as possible, to that at the operating level (55 to 60 percent, when controllable).

6.8.3 Repairs

Conductive floor repairs should be accomplished by matching the existing material and workmanship as closely as practicable, following the floor manufacturer's recommendations. A test for conductivity must always be made after the repair has been completed. (See paragraph 6.8.2 for test procedure.)

6.8.4 Maintenance

Conductivity floors must be both sanitary and conductive. Improper cleaning methods that allow a film to cover the floor, thereby prevent conductivity, will render the floor useless in preventing explosions from static electricity. Custodial services are discussed in the Tri-Services Manual, "Military Custodial Services Manual" (TM 5-609, NAVFAC MO-125, AFM 91-2)

SECTION IX—RESILIENT FLOOR COVERINGS

6.9.1 General

Resilient floor coverings generally used include linoleum, vinyl plastic tile, vinyl asbestos tile, asphalt tile, cork tile, and rubber tile. Floor coverings should be selected carefully and laid according to the manufacturer's recommendations. If felt lining is necessary, it is cemented to the floor, and the resilient covering is bonded to the felt. In other cases, the covering may be bonded directly to the floor. Any cement paste or primer used directly on the floor should effectively seal the pores in the floor.

6.9.2 Protection of Coverings

Heavy furniture or equipment should not be dragged across resilient floors. Suitable rests should be provided on furniture and equipment such as lockers, files, and cots to distribute the weight when such objects are placed permanently on the floor. The maximum static load limit per square inch for asphalt tile is approximately 25 pounds; for cork tile, 40 pounds for composition tile, 50 pounds for linoleum, 75 pounds; and for rubber tile, 200 pounds. Chairs, desks, and other movable equipment should be fitted with flat-faced gliders not less than 1 ½ -inches in diameter. Chair-roller, wheels or casters should be at least 2 inches in diameter and have a ¾-inch-wide face; the whole caster should revolve freely. Most flexible floor coverings are designed for interior use and should

not be installed where they are exposed regularly to sun and rain, extremes in temperature, hot water or steam, and damaging solvents, greases, and oils.

6.9.3 Care of Installed Equipment

Before covering is laid, all pipe rails, radiators, space heaters, water coolers, and other equipment that will interfere with installation of the covering should be disconnected and removed from the work area. When the equipment is reset, necessary provisions should be made in all connections to accommodate the increased thickness of the floor. Pipe passing through the flooring should be wrapped with at least two turns of asphalt-saturated felt and the space between pipe and flooring loosely packed with glass wool or similar fire-resistant material.

6.9.4 Adhesives

Adhesives for use with felt- or fabric-backed flexible floor coverings should conform to the floor-covering manufacturer's recommendations. Under dry conditions, most linoleum pastes show high adhesive strength, but few have sufficient resistance to moisture to suitably bond floor coverings to subfloors in humid locations. Lignin paste is suitable for bonding linoleum and felt-backed materials in dry locations only. Cumar resin and resin-oil cements show fair resistance to moisture. Cements and primers for use above grade floors with asphalt-saturated flexible floor coverings should be of the asphalt-emulsion type or as recommended by the floor-covering manufacturer.

6.9.5 Underlayments on Wood Floors

Lining felts and floor coverings may be applied directly to wood floors providing there are no cracks or ridges. Otherwise, plywood, hardboard, or other underlayment may be required.

6.9.5.1 *Rigid and Semirigid Board Types.* Plywood should be laid face side up to receive the finish floor. It should be three-ply sheathing grade conforming to commercial standard CS 45-55 and be a minimum of ¼ inch thick with exterior glue. Increased thickness may be necessary, depending on the structural adequacy of the subfloor or to achieve uniform alignment with adjacent existing finish floors. Whenever possible, plywood should be laid so that the face plies are at a right angle to the wood subfloor. When the subflooring is laid diagonally, the face plies should be laid at a right angle to the joist or sleepers. Hardboard is less desirable as underlayment than plywood. If used, it should be laid with the back or rough side up, to receive the bonding paste. Plywood and hardboard underlayment should be face-nailed to the existing floor, with 1¼-inch hardened screw-type or ring-grooved underlayment nails placed 6 inches on center at the edges and 12 inches on center in the middle of the sheet. Nails should be driven flush with the surface of the board. Staples should never be used as underlayment fasteners.

6.9.5.2 *Troweled on Types.* When using underlayments of the troweled-on type, follow the manufacturer's recommendations for mixing, application, and curing.

6.9.6 Crack Fillers for Wood Floors

All holes or cracks in wood floors or underlayments should be filled with a suitable crack filler before flexible coverings are laid. Crack fillers should adhere tightly to crack surfaces, have minimum shrinkage, and resist crumbling or powdering under traffic. Factory-prepared commercial fillers should be applied according to the manufacturer's recommendations. Job-mixed fillers are composed of 90 parts fine sawdust and 10 parts a fast-drying organic vehicle, such as lacquer, shellac, or an approved commercial shellac substitute. Filler is made by adding the vehicle to the sawdust until a medium-stiff, easily worked paste is obtained. Only the amount that can be used in approximately 80 minutes should be mixed at one time. The filler should be worked into holes and cracks, smoothed off flush with the surface of the floor or underlayment, and allowed to dry for at least 1 hour before the floor covering is laid.

6.9.7 Vinyl Sheet Flooring

6.9.7.1 Vinyl sheet flooring is available in a wide variety of product characteristics including color, texture, and resilience. They may be used in a variety of environments based on the thickness of wear layer and conditions of the floor structure. Flooring should conform to Federal Specifications L-F-475 or L-F-1641. Installation practices and maintenance as specified by the manufacturer should be followed in all cases.

6.9.7.2 *Job Preparation.*

a. Job Inventory. The room should be measured wall to wall in at least two locations each for length and width, making allowances for doorways. An additional 3 inches should be included in each measurement. When more than one width of material is to be used, an additional allowance of 3 inches is required per run for fitting the first and successive sheets. Length allowance must consider pattern repeat characteristics of the flooring. Some flooring patterns require sheet reversal at the seams which must be considered prior to cutting.

b. Removing Old Sheet Flooring. CAUTION: Most sheet vinyl floorings contain asbestos or other inert fibers which may cause serious bodily harm.

Do not remove backing or lining felt by sanding or grinding or any method which will create dust. Have a sample of the old sheet flooring tested for asbestos. If asbestos is present, special removal procedures will be required. If the existing floor covering is well bonded, several products may be laid directly on the existing surface. If removal is required, the recommended method is to cut the wear layer into narrow strips of 4 to 18 inches wide, depending on the product. The covering may be split from the backing and pulled at a sharp angle or core-rolled. The remaining felt will normally have a surface smooth enough to accept the new floor. Removal of the felt backing must be done in strict compliance with the manufacturers' recommended procedures.

6.9.7.3 *Installation.* Sheet flooring containing asbestos should not be used. Sheet flooring may be applied to either concrete or wood floors under certain conditions. Both types of floors must be free of moisture at all times or the floor covering may warp or become damaged.

a. Concrete floors. Concrete subfloors on or below grade must be tested for moisture. The floor should be cleaned by thorough sweeping with a wire brush to remove all loose particles, followed by priming or sizing in accordance with the manufacturer's recommendations. The floor may be tested for moisture by installing small panels throughout the floor area. This test should include areas of the subfloor which are least subjected to drying conditions. If the panels are securely bonded after 72 hours, it may be concluded that the floor surface is dry and sufficiently clean of foreign particles to permit installation. All holes, cracks, and joints in subfloors must be filled using products recommended by the manufacturer of the floor covering. Prior to installation, the floor should be swept or vacuumed clean of all dirt and debris.

b. Loose-Lay of Floor Covering. If only one width of flooring is to be installed, it should be unrolled and layed out and marked with the room diagram using a wax pencil. Allowance for excess material (1½ inches per side) must be considered. The covering can then be cut using a utility knife to the oversized dimensions of the room and transported to the room. It is a good practice to allow the covering to lay full unrolled, flat on the floor, in a warm room (70° F) or (21° C) for about 24 hours before cementing it into place. The covering can be trimmed with a utility knife. Door jambs and corners must be trimmed carefully to avoid miscuts which may be exposed or provide a poor fit.

c. Bonding. Adhesives will be specified by the floor covering manufacturer based on type of subfloor or underlayment and floor covering material. Adhesives should be warmed at 70° F for 48 hours prior to installation and should be applied using a notched trowel.

d. Seams. If seams are required, advance planning must avoid placing a seam within 6 inches of joints in the underlayment. After the first sheet is flattened to the floor, the second sheet should be overlapped so that the design matches exactly. The sheets should be taped together to avoid slippage. A scrap piece may be laid under the overlapping pieces to provide a better fit and to allow a better cut of the lower sheet without damaging the underlayment. The cut should be made using a sharpened blade and metal straightedge through both layers of the overlap. The knife must be kept straight to avoid a beveled edge which cannot be sealed properly. The sheets may then be folded back and the adhesive applied to the underlayment. Insure that no excess adhesive is left which may ooze up into the seam. The flooring should be rolled into the adhesive using a weighted roller.

e. Seam Sealing .Use seam sealers recommended by the manufacturer only. Insert the vertical metal fin of the seam sealer applicator into the joint at one end of the seam and apply very light pressure to lay out a bead of sealer. The sealer will weld the vinyl core and the wear layer. Care should be exercised to avoid spilling the seam sealer. If this happens, no attempt should be made to remove it. Seams should not be disturbed for 24 hours after completion to allow welding process to be complete.

6.9.8 Asphalt Floor Tile

6.9.8.1 *General.* Asphalt flooring tile is suitable for installation on most wood and concrete subfloors above grade and concrete floors in contact with the ground. Asphalt-tile is made of a blended composition of asphaltic or resinous binders, asbestos fibers, plus insert fillers or pigments, formed and cut to size under heat and pressure. This material is one of the few resilient floor coverings that can be used to advantage on concrete slabs on ground where some resistance to moisture is necessary. Asphalt tile, available in many plain and marbelized colors, not only presents an attractive appearance but offers other important advantages. It is quiet, comfortable, safe to walk on, extremely durable, and highly resistant to abrasive action of foot traffic and common abuses such as scuffing and cigarette burns. It is an odorless, nonabsorbent covering which does not originate dust; it is easy to clean and has a low

maintenance cost. All these factors make it particularly desirable for use when high sanitary standards must be maintained. When exceptional abuse or severe accident makes repair necessary, new units to replace the damaged ones can be inserted easily.

6.9.8.2 *Characteristics of Asphalt Tile.* The following are important characteristics of asphalt tile:

a. Color Variations. Asphalt tile is manufactured mainly by converting batches of several raw materials into units of the finished product. Due to the human element involved and variances of raw materials, such a process naturally results in slight variations in tile colors. These color variations, which are characteristics of the product, are not noticeable in designs and patterns of two or more colors. Differences in shade are generally noticeable when floors are laid in solid colors. However, the effect can be minimized by mixing the tile from several cartons as the tiles are applied.

b. Effect of Grease and Oil. Since asphalts and asphaltic resins are soluble in oil and grease, it is obvious that ordinary asphalt tile is not adapted for use in kitchens, gas and oil stations, machine shops and adjacent office areas, behind meat market counters, or in mess halls.

c. Effect of Acids. Although asphalt tile has considerable resistance to acid, it is destroyed by high concentrations and is not recommended for use on floors exposed to strong acid solutions. It may be used satisfactorily in laboratories if spilled acids are normally removed immediately.

d. Effects of Temperature and Sunlight. Asphalt tile is not adapted to outdoor locations exposed to the sun or to use on floors subjected to continued or intermittent extremes of cold and heat.

e. Effect of Moisture. Although asphalt tile is not affected by the normal dampness in concrete slabs on ground or by moisture resulting from normal maintenance, it is not recommended for floors constantly exposed to wet conditions. it is not suitable for use in shower stalls or adjacent floor areas or for open porches and other outside locations. Continued exposures to water impairs the cement at joints, eventually shrinking the tile so that it loosens from the subfloor.

6.9.8.3 *General-Purpose Asphalt Tile.* General-purpose asphalt tile and base should conform to requirements of the Federal Specification SS-T-312. A preferred size is the standard 9 x 9 inches. Other available regular sizes are 12 x 12 and 18 x 24 inches. Other sizes in square and rectangular shapes are made by one or more manufacturers but are not always carried in stock. Several sizes in octagon and hexagon shapes and half tiles for diagonal installations are available at extra cost. Asphalt tile is available in **c**- and $^{3}/_{16}$-inch thickness, weighing approximately 1**a** and 2 pounds per square foot, respectively. The **c**-inch-thick tile is recommended for most installations. Straight and cove-bottom types of base are furnished in heights of 4 and 6 inches. General-purpose asphalt tile is divided into Groups A, B, C, and D, according to color and cost. Group A colors, plain and very dark, are most economical in cost. Group B, at a slight additional cost, covers the dark plain and marbelized colors. Group D colors are light, plain and marbelized, and the most expensive. It should not be inferred that the more expensive tile is of better quality, but simply that because of special pigments and resins the manufacturing cost of light-colored tile is greater than for dark-colored tile. Grease-resistant tile and base is obtainable in two classes: Class I, which is resistant to edible oil and alkali; and Class II, which is resistant to mineral oil and alkali. Class I is recommended for installation in dining spaces of mess halls and areas where oil spillage may occur. Grease-resistant tile is more expensive than any of the general-purpose tiles.

6.9.8.4 *Preparation of Sub/Floors.* Refer to preceding paragraphs for descriptions of wood and concrete floor preparation and the installation of underlayments.

6.9.8.5. *Lining Felt.* Lining felt for application over new or reconditioned wood-strip floors should be an asphalt-saturated asbestos fiber or rag felt of a type made specially for use under asphalt tile. A dry felt is not satisfactory because it gives too soft a cushion under the tile and permits excessive indentation of tile under loads of chairs and other pieces of furniture. Also, a dry felt may split and crawl when subjected to moving traffic. Procedures for laying felt are described in paragraph 6.9.7.3.1. Felt is not required when asphalt tile is laid over plywood, hardboard or smooth concrete.

6.9.8.6 *Adhesives.* Use only adhesives approved by manufacturer of the asphalt tile.

a. Linoleum Paste. Linoleum paste is used to secure lining felt to wood-strip flooring.

b. Asphalt Base Primers. Primers for use on concrete floors and mastic underlay shall be of the following types:

(1) *Emulsion-Type Primers.* This primer is a homogeneous emulsified asphalt of such consistency that when mixed with water it can easily be brushed to full coverage on the floor. This type of primer should be used only on suspended concrete floors that have heated or well-ventilated spaces underneath.

(2) *Cutback-Type Primers.* This primer is composed of an asphaltic base and a suitable light, volatile solvent. Consistency should be such as to afford easy brushing on the floor. This type primer is required on concrete subfloors on or below grade and on new concrete subfloors which may contain concealed moisture. It is optional for use on suspended concrete subfloors which have heated or well-ventilated spaces underneath.

c. Asphalt Base Cements. Asphalt cements made specifically for bedding and fastening asphalt tile shall be of a heavy consistency which can be applied and spread effectively with a standard toothed trowel.

(1) *Emulsion-Type Cement.* This cement is a homogeneous emulsified asphalt suitable for use without the addition of other ingredients. See Federal Specification MMM-A-1 15.

(2) *Cutback-Type Cement.* This cement is composed of an asphaltic base and suitable volatile solvents. See Federal Specification MMM-A-110.

(3) *Cove Base Cement.* Cove base cement should be a semi-waterproof type made specifically for use with asphalt tile.

6.9.8.7 *Use of Asphalt Cements.* Asphalt tile may be secured to most types of subfloors with an emulsified asphalt cement. However, a moisture-resistant, cutback asphalt cement is always necessary for securing asphalt tile to concrete subfloors which rest directly on the ground. Asphalt cements are used as adhesives and never in place of underlayments for smoothing rough surfaces. Too much adhesive is usually applied when attempting to fasten asphalt tile over rough or uneven subfloors, and this results in "bleeding." In addition, the tile does not have sufficient contact with the subfloor to make a satisfactory bond and eventually loosens. An excess amount of the cutback-type cement not only results in bleeding but prevents early evaporation of the solvents. This may soften the asphalt tile and lower its resistance to indentation. Cutback cements must not be used with asphalt-saturated felt or asphalt-type underlays, since the solvent in the cutback will be absorbed into any asphaltic base and soften it. This causes the adhesive to lose its bonding effectiveness, and the tile may loosen and curl. The solvents in cutback asphalt adhesives are flammable and volatile and must not be exposed to open flame. Adequate ventilation must be provided to take off fumes. See that fire extinguishers are conveniently located. Keep the asphalt cement containers tightly closed in storage as evaporation of solvent will cause the cement to become too thick for proper application. Some asphalt cements freeze at low temperatures. When freezing occurs, thaw the cement in a warm room for several days, keeping container tightly closed. Stir thoroughly before using. Delivery of adhesives in the manufacturer's sealed containers with the labels intact and seals unbroken should be required.

6.9.8.8 *Installation of Asphalt Tile.* Installation of asphalt tile should conform generally to the manufacturer's printed recommendations. Tile is cemented directly to cleaned and prepared concrete slab, plywood or hardboard underlay. Tile laid over wood-strip flooring is usually cemented to lining felt previously cemented to the reconditioned flooring.

a. Layout. Before tile is laid, the floor area must be squared and the best method of laying determined. This will depend on the shape of room, location of fixed furniture and doorways, and the tile design selected. Definite and specific instructions that will apply in all cases cannot be given. Asphalt tile should be laid parallel to walls which are at right angles in order to eliminate unnecessary cutting of the field tile and borders. Always start at the center of the room and work toward the walls so that border widths can be adjusted accordingly.

b. Temperature. Temperature of the cement, asphalt tile, room and subfloor must be maintained at 70° to 80° F (21° to 26.7° C) for at least 24 hours before and 24 hours after the laying process. Never apply cold tiles because condensation may form on the underside and break down the bond of the cements. If any tiles are warped when removed from the shipping cartons, pile them on a flat surface near a radiator or in a very warm room until they become flat. Adequate ventilation is important because it hastens drying and maintains the adhesive properties of cement by preventing condensation of moisture.

c. Spreading Cement. Stir the asphalt tile cement to uniform consistency in container. Spread cement evenly over the floor ahead of tile laying, using a notched trowel. Allow the cement to dry for approximately 30 minutes or until a tacky condition is produced before setting the tile. If tile is applied too soon, the unevaporated solvent in cutback cements may soften the tile, leading to possible excessive indentation later. If the interval between cement spreading and tile laying is too long, a poor bond will result.

d. Laying Asphalt Tile. When the cement has become sufficiently dry, lay tile according to predetermined design and layout. Field tile should be laid first. Cut and fit the border tile accurately against

walls, built-in equipment, and other permanent projections and recesses. Lay so that joints fit closely and form straight lines. Avoid squeezing the joints, as tile will expand and buckle with an increase in temperature. Embed each tile firmly to prevent movement under traffic. When heated, asphalt tile can be cut with a linoleum knife or scored deeply to give a clean break. Apply heat slowly to back of tile to prevent blistering. Asphalt tile cutters are recommended for making straight cuts. A pin vice fitted with a steel phonograph needle is a convenient tool for scoring. Make a pencil mark at each end of the piece to be cut, place a straightedge between the two marks, and score a deep scratch along the straightedge. Snap off the piece of tile, making sure to start the pressure at one end of the scratched line rather than at the center of the piece. This method of cutting can be done only with the grain, never diagonally or across the grain. Exposed job-cut edges should be sandpapered smooth.

e. Cove Base. The installation of a 4-inch-high cove base as part of the asphalt tile flooring may be desirable. However, in areas where cove base is subject to frequent bumping by furniture or floor-furnishing equipment, rubber tile appears more durable than asphalt tile. Vinyl cove base may also be used. Some base materials are furnished in prefabricated outside corners which are easy to install and give a neat appearance to outside corner work. Instructions furnished by the manufacturer of the base material used should be followed in the selection of materials and fitting the base in place.

f. Removing Asphalt Cement Spots. If asphalt cement oozes up at joints or is smeared on tile surfaces during the setting, scrap off immediately with a putty knife and rub with a cloth saturated with a mild neutral soap. If this does not remove all trace of the cement, use 00 steel wool and a wet scouring powder, rinse off the clear water, and dry the surface.

6.9.8.9 *Finishing* Improved appearance and longer useful life will result if asphalt tile floor is cleaned and waxed before being put into use. Cleaning, especially wet washing, and waxing should be postponed untile tile has properly bonded to subfloor or underlay. Should water or wax get under tile before cement has hardened, the bond may be destroyed and the tile will curl and break. As a precautionary measure, tile should not be cleaned or waxed for 2 weeks after setting. If floor must be used during this period, protect tile with a covering of paper, fabric, or wood walkways.

a. Prewaxing at Factory. Factory-waxed tiles eliminate the necessity of waxing after the tile is laid. Prewaxing also protects the surface of tiles against damage during transportation and installation. However, even factory-waxed tiles must be protected if tile is laid before construction is completed. Cover tile floors with building paper, fabric or boards, especially at entrances and along traffic aisles.

b. Initial Waxing Water-emulsion waxes, free from oils and volatile organic solvents and conforming to Federal Specification P-W-155, are safest for use on asphalt tile floors. Do not use paste or liquid waxes containing solvents such as gasoline, benzine, turpentine, or oils. Such solvents will soften asphalt tile and cause the colors to run. Best results are obtained by initial application of two thin coats of water-emulsion wax. Allow approximately 30 minutes for each coat to dry to a hard, medium-bright finish. Drying time depends to a large extent on room temperature, humidity and ventilation. A higher gloss is produced by use of a power-driven buffer. Wax must be dry when buffed.

6.9.8.10 *Radiators on Asphalt Tile.* A radiator or other heavy fixture on legs should not be set directly on asphalt tile. The weight of the radiator, together with the softening effect of heat, may cause the legs to sink into tile, resulting in bulges and breaks. If tile is laid before the radiators are set, cut holes in the tile and insert a hard material to form bases for the legs. Ceramic tile, iron washers, or other metal disks of the same thickness as the tile make satisfactory bases. A piece of 1-inch pipe, ground on the outside to form a die punch, is helpful in cutting holes for radiator leg bases. When tile is laid over concrete, ball bearings can be used for leg bases instead of the materials suggested above. Heat asphalt tile and tap the ball bearings down with a hammer. In the event radiators have been set before tile is laid, raise the radiator, slide tile underneath, and place a heated ball bearing under each leg. Weight and added heat of the radiator will force the ball bearing down to the concrete subfloor.

6.9.8.11 *Tile on Stair Treads.* Do not leave asphalt tile with unprotected edges on stair treads and landings. Suitable metal, plastic, or wood edgings must be fastened to the tread nosing to protect tile edges and eliminate the tripping hazard. Do not use edging strips which have concealed horizontal flanges because the tile may crack at the rear edge of flange.

6.9.8.12 *Precautions.* Preparation of new subfloors and the reconditioning of old subfloors should be given special attention before laying tile. Asphalt tile floors should not be installed until

other trades have completed their work. When necessary to install the asphalt tile floor before other trades have completed their work, protect the finished floor with building paper or other suitable material. See that temperature of room and all materials is maintained at 70° to 80° F (21° to 26.7° C) for 24 hours after installation. Install asphalt tile only over subfloors that are smooth, firm, and free from oil, grease, and other foreign matter. Do not lay asphalt tile over any resilient floor such as cork tile, rubber tile, linoleum, or dry felt. Asphalt tile should not be laid over a below-grade wood floor or one that is springy or has loose boards. Legs of lockers, desks, cases, cots and other items of furniture not subject to frequent moving will be provided with suitable furniture resets or wood blocks to prevent excessive indentation. Do not install asphalt tile where it will be exposed to excessive water, such as in open porches, kitchens, dish-wash rooms, shower compartments and adjacent dressing spaces. Use the type of adhesive recommended by the tile manufacturer for each particular installation. Directions for use of adhesives are usually on the labels of the containers. Never use sweeping compounds containing free oils, sand, or other abrasives. Avoid as far as possible, the use of gasoline, turpentine, benzine, and similar solvents as cleaning agents. Should it be necessary to use one or more of these materials, keep the room well ventilated, and see that no open flame is nearby. Use safe water-emulsion-type waxes. Do not use waxes known to contain oils or other solvents. Asphalt tile in toilet rooms should not be waxed, especially around urinals, as uric acid dissolves the wax and will leave a spotty appearance. Frequent damp mopping is the best method of cleaning. Before using a new cleaner or wax on the asphalt tile floor for the first time, moisten a white cloth with a material and rub over the surface of one or two tiles. If tile color shows on the cloth, a solvent has dissolved part of the tiles' surface and the material is not safe for use on asphalt tile. A safe procedure is to get the advice of the asphalt tile manufacturer before purchasing an unknown cleaner or polishing material.

6.9.9 Vinyl-Asbestos Floor Tile

6.9.9.1 *Material.* Vinyl-asbestos tile conforming to the requirements of Federal Specification SS-T-312 consists of thoroughly blended composition of a thermoplastic binder, asbestos fibers, mineral fillers, and pigments. The binder consists of a PVC resin or a copolymer resin compounded with suitable plasticizers and stabilizers. Tile shall be 9 or 12 inches square and **c** inch thick.

6.9.9.2 *Recommended Installations.* Vinyl-asbestos tile may be installed over and above grade subfloors directly or with a lining felt depending on the condition of the floor. Normally, a lining felt is used with strip flooring, and direct application is used over plywood and hardboard. Vinyl-asbestos tile is not applied on or below grade subfloors. The one exception is a concrete floor which has a membrane waterproofing. Vinyl-asbestos can be bonded directly to metal or concrete stairs.

6.9.9.3 *Preparation of Subfloors.* Refer to the preceding paragraphs and use vinyl manufacturer's recommendations for descriptions of wood and concrete subfloor preparation and the installation of underlayments.

6.9.9.4 *Installation of Tile.* Conditioning the materials and work area and laying vinyl tile is accomplished in much the same manner as described for asphalt tile in paragraph 6.9.8.8. Additional specific recommendations of the vinyl tile manufacturer relative to lining felt, adhesive, and installation procedures will be followed closely.

6.9.9.5 *Maintenance After Installation.* Vinyl floor tiles are one of the easiest floors to maintain. After installation is completed, the floor will be allowed to set for 4 or 5 days before beginning maintenance. This will allow the adhesive to set and become thoroughly hard. A sufficient first cleaning action can be accomplished by use of lukewarm water and a mild soap or other cleaner recommended by the tile manufacturer. Rinse with clean water and mop dry. Never leave any standing water. If the floor has become badly soiled during installation, it should be given a machine buffing with 00 or 000 steel wool, after which steel wool particles and dirt are removed by vacuum cleaner or soft broom sweeping. A machine buffing with a soft bristle brush immediately after the first washing or steel wool treatment should bring back the original gloss. Initial waxing should be accomplished when the floor is laid and cleaned. After installation is completed, allow at least 24 hours before heavy furniture or other equipment is moved on the floor. The weight of fixed and movable furniture and other equipment often causes indentations in resilient floor coverings. Legs of chairs, desks, tables, etc., should be fitted with wide-diameter, flat-faced metal or composition gliders or cups specially designed for the purpose. Where the design of the equipment does not permit the use of gliders or cups, blocks of wood of ample size will be placed under the bearing corner.

6.9.10 Cork Tile

Cork tile may be laid on wood or concrete floors that are not in direct contact with the ground. Tiles are made of raw cork and resins, are unbacked, and are **c** inch thick. They have good durability but only fair resistance to grease and alkalies. Tiles should be laid according to the manufacturer's recommendations.

6.9.11 Rubber Tile and Sheet

Rubber-tile flooring may be laid on concrete floors in direct contact with the ground if the floor is not below grade. Slabs on grade must be membrane-waterproofed to receive rubber tile and sheet. Rubber tiles are equal in durability and maintenance requirements to linoleum and vinyl tiles. For slip-resistant floors, rubber-sheet floor coverings are made with a wearing surface of a compound of natural, synthetic, or reclaimed rubber, with or without a backing of cotton or fabric. Rubber sheeting conforms to Federal Specification ZZ-M-71d. Finished surfaces have longitudinal, diamond-, pyramid-, or knob-shaped corrugations. Thicknesses range from **c** to ¼ inch and widths from 24 to 42 inches. Rubber tiles and sheets are laid according to the manufacturer's recommendations.

6.9.12 Repair of Resilient Floor Coverings

6.9.12.1 *Repairing Linoleum.* Repair comparatively small areas of damaged linoleum by laying out the area along rectangular lines and laying an oversized section of new linoleum over the damaged area. Cut through the two layers simultaneously to insure a tight fit. Remove the damaged section and clean the exposed underfloor of adhesive, dust, and dirt. Replace damaged felt lining. Apply a linoleum adhesive to the exposed surface and fit the new linoleum in place. Roll the area with a linoleum roller and place weights of suitable size on the patch to assure proper adhesion.

6.9.12.2 *Repairing Resilient Tile.* Repair resilient tile by removing the damaged section and replacing it with new material. Tile is more easily replaced than linoleum because of its smaller size. After removing damaged tile, scrape the exposed area level, and clean off all mastic, dust, and dirt. Replace damaged felt lining. Install new tile in suitable cement or mastic in accordance with the manufacturer's recommendations.

6.9.12.3 *Resurfacing Cork Tile.* Improve the appearance of cork tile after abuse of long service by sanding the tile with No.1-½ sandpaper, followed by finish sanding with No.00 paper. After each sanding, sweep the floor to remove cork dust. After the final sanding, wash the floor with a synthetic detergent cleaner, rinse it by damp-mopping with clean water, and dry it. Apply two or three coats of water-emulsion wax suitable for cork tile. Buff the wax with a polishing machine after each coat has dried.

6.9.13 Maintenance of New Resilient Floor Coverings

Newly installed resilient floor covering should be maintained in accordance with Tri-Services Manual "Military Custodial Services Manual" (TM 5-609, NAVFAC MO-125, AFM 91-30).

SECTION X—RESINOUS FLOOR FINISHES

6.10.1 General

Resinous floor finishes (also known as seamless coating systems) are a relatively new development. As such, only very limited experience has been gained in the selection, installation, maintenance, and repair of these floor systems. The resinous floor system is composed of the resins, hardener, and fillers. The resin is the binder which holds the mass together and bonds the floor coating to the base floor. The hardener converts the liquid resin into a solid. The filler, which can be any material fairly inert to chemicals, adds to impact strength and brings the coefficient of thermal expansion of the resin closer to that of the base floor. Despite convenient classifications into generic types of resin binder, chemical analysis by the National Institute of Science and Technology indicates that there is not always a clear distinction between these types. No matter what the generic type (epoxy, polyester, polyurethane), the prepolymer and catalyst (hardener) must be chemically designed for the particular floor coating. The properties and performance of the combination of materials will vary widely with the particular formulation. The resin binders may also be combined with other ingredients, such as aggregates, to provide a wearing surface.

6.10.2 Materials

Outlined below are the components for the resinous floor. It must be stressed that these components must be from the same manufacturer and formulated for the particular resinous floor covering. Materials must be stored for at least 24 hours at a temperature of not less than 50° F (10° C).

Methyl methacrylate (MMA) based acrylic reactive resin systems generally cure down to 24° F (4.5° C) (and lower) and do not require special storage before use.

6.10.2.1 *Primer.* Primer, a material recommended by the manufacturers of the resin, will penetrate into the pores of the substrate (base floor). The primer must blend with the topping to form a permanent monolithic floor-covering system.

6.10.2.2 *Resinous Binder.* This is the basic resinous material which will constitute the major ingredient in the floor-covering system.

6.10.2.3 *Catalyzers (Hardeners).* A catalyzer is a product which will catalyze or harden the resin binder when added in the correct proportions and thoroughly mixed.

6.10.2.4 *Fillers.* This material is composed of inert mineral or cellulosic ingredients best suited for the resin binder. Normally, fillers are used to impart the color and physical characteristics to the floor covering.

6.10.3 Types

Resinous floor coverings are classified by generic type of resin binder and subclassified by method of application. Some resinous floor coverings are generally known as decorative, brush-on or roll-on, monolithic flooring. This type of covering is closely related to floor enamel. Another type of covering is mixed with the aggregate in a concrete mixer and is troweled on in the same manner as a concrete topping. A third type also resembles a concrete floor topping, but the aggregate is decorative, usually marble chips, and after hardening it is ground with a grinder.

6.10.3.1 *Epoxy.* Epoxy coverings may be brushed-on (rolled-on), troweled-on industrial or thin-set terrazzo.

6.10.3.2 *Polyester.* Polyester coverings may be troweled-on industrial or thin-set terrazzo.

6.10.3.3 *Polyurethane.* Polyurethane coverings may be brushed-on (or rolled~n) or troweled-on industrial.

6.10.3.4 *Methyl Methacrylate.* MMA-based reactive systems are used from brushed-on (rolled-on) coatings to self-leveling and troweled-on decorative industrial and commercial type floors. They can generally be trafficked 1 to 2 hours after application.

In addition to the types mentioned above, it is expected that advances in technology will develop new seamless floor (and wall) covering systems which will consist of layers of different generic types such as an epoxy base and a polyurethane finish.

6.10.4 Floor Systems Selection

The selection of the particular floor system depends on the ability of the system to withstand exposure conditions. Polyesters are suitable for resistance to detergents but not for exposure to strong alkaline solutions like sodium hydroxide. Epoxies should not be used where resistance to oxidizing acids or resistance to temperature more than 130° F (54.5° C) are required. MMA-based systems are excellent against heat shock, mechanical impact, salts, alkalies, organic and inorganic acids but should not be used where solvents are spilled regularly. Where doubt exists as to the suitability of a particular resinous material, inquiries should be directed to the next highest echelon of command.

6.10.5 Preparation of Substrate

This is the most critical phase of the installation of resinous floor-covering systems. Most bond failures have been traced to improper preparation of the substrate surfaces. In the case of newly poured concrete surfaces, the concrete must be a minimum of 28 days old. A distinction should be made between new concrete and existing slabs that need rehabilitation work. New slabs are prepared by sandblasting and abrasive, steel shot blasting. Old slabs should be prepared mechanically by sandblasting or abrasive blasting, scarifying or scabbling. The substrate surface must be swept clean and must be free of paint, oil, grease, or any other material that will affect the bonding or the smoothness of the applied floor covering. In the case of a concrete slab, the surface should be etched with a 10-percent solution of muriatic acid applied by mopping or brooming. Allow the acid to remain about 10 minutes or until the bubbling ceases. Thoroughly wash the surface with clean water, removing all residue. Allow the surface to thoroughly dry. Cracks or uneven areas of the substrate must be patched or repaired with materials recommended by the resin manufacturers.

6.10.5.1 *Priming* When the surface is thoroughly dry, the primer is applied insuring that the entire surface is coated without flowing and collecting in depressions.

6.10.5.2 *Application.* The interval between priming and application of the resinous floor covering is in strict accordance with the manufacturer's instructions. The coating is applied to the finished thickness depending on the type of resin, the exposure of the floor covering, and the decoration desired. Thicknesses range from $^{3}/_{16}$ to $^{5}/_{16}$ inch. Cove bases are normally cast-in-place, resinous, covering

material with a 1-inch radius curve and are from 4 to 6 inches high.

6.10.5.3 *Finishing.* Brush-on (or roll-on) types are finished with a sealer if required by the manufacturers. Troweled-on types are troweled to a uniform smooth finish. After curing, in accordance with the manufacturer's directions, a sealer coat is applied. Thin-set terrazzo must have the exposed surface ground smooth after the curing is completed. Grout is applied and worked into pinholes and other voids. Excess grout must be removed as soon as possible. After the grout has cured, the surface should be ground to a smooth uniform finish. After the final grinding, the surface must be washed with a neutral cleaner and rinsed with water. When the surface is thoroughly dry, the sealer coat is applied.

6.10.5.4 *Protections.* All completed work should be protected until the floor is placed in service. This is especially true when other construction operations are in progress.

6.10.6 Maintenance and Repair

Resinous floors are maintained the same as terrazzo floors. Normal custodial services provide the necessary maintenance. Due to the recent use of these floor covering materials, few floors have been repaired. When repairs have been made, MMA- and polyester-based systems have proved to be the most successful because the new resins bond monolithically to the existing systems without leaving cold joints. The damaged area and 6 inches adjacent to the damaged area are completely removed down to the substrate (base floor). The substrate is prepared as for a new floor (see paragraph 6.10.5). The resinous material is leveled with the existing floor covering. Aggregate or decorative chips are added if required. When curing is completed, some systems may require grinding the edges smooth. Present practice indicates that the preparation of the substrate is the key to successful resinous floor repairs.

SECTION XI—STAIRS

6.11.1 Repairs

6.11.1.1 *Wood Stairs.* Exterior wood stairs are subject to weathering and mechanical abuse. Normally, damaged components should be removed and replaced in kind. Maintenance on interior wood stairs usually involves treads. Squeaks indicate loose treads, which can be corrected by driving finishing nails through the treads into the riser or carriages, or by removing the molding under the tread overhang, driving wood wedges between the tread and riser, renailing the tread tightly, and replacing the molding. In open string stairs, a tread that is worn but not split or broken may be removed and reversed. Split, broken, or otherwise seriously damaged treads should be replaced with new boards. Housed treads that cannot be removed may be repaired by leveling the worn surface with asphaltic mastic or other suitable plastic materials and covering the tread with a suitable floor covering. Plain and nonslip nosing of steel, brass, bronze, aluminum, and molded hard rubber are commercially available and should be applied according to the manufacturer's recommendations.

6.11.1.2 *Concrete Stairs.* Concrete stair treads that are cracked, chipped, or spalled may be patched according to recommendations in paragraph 6.3.2.

6.11.1.3 *Terrazzo Stairs.* Terrazzo stairs, because of the nature of the material and general conditions of use, usually require limited maintenance. Cleaning for removal of discoloration may be necessary and should follow the procedure recommended in paragraph 6.4.3.

6.11.1.4 *Metal Stair&* Metal Stairs, especially when exposed to the weather or corrosive agents, should be given a coat of rust-resistant paint. Rusted fasteners should be replaced and properly secured.

6.11.2 Application of Coverings

The elimination of hazards may require the application of slip-resistant coverings on treads of exterior or interior stairways. Some types of bituminous-base coverings are furnished with a slip-resistant wearing surface, which makes them efficient materials for use on stair treads. A mineral-surfaced, nonslip covering, consisting of silicon carbon grains coated on a heavy, tough semisaturated fabric, is also available commercially. The fabric has a backing of pressure-sensitive adhesive. Rubber mattings may also be applied to treads to reduce slipping hazards.

SECTION XII—CARPET

6.12.1 General

Carpeting is a common authorized floor covering for uses in quarters and select administrative, recreational, and education facilities. Guidelines on the selection and characteristics of authorized carpeting may be found in Engineer Technical Letter 1110-3-323, "Carpet in Army Facilities," NAVFAC Design Manual 14.2, "Carpet Selection Guide," and Air Force Design Manual.

6.12.1.1 *Care and Maintenance.* Routine custodial care and maintenance of carpets should be maintained to avoid excessive wear caused by surface soil penetrating to the lower pile and backing. Procedures for care and maintenance are in the Tri-Service Manual (TM 5-609, NAVFAC MO-125, AFM 91-2 Military Custodial Services.

6.12.1.2 *Repairs*

a. Spot Repairs. Small repairs to carpet pile may be made by resetting individual tufts in the affected area. This procedure may be used in cases of small burns or serious stains where the carpet backing is unaffected. Carpet pile should be cut down to the backing and stubs removed. New individual tufts should be stripped from a piece of scrap carpet or from an inconspicuous part of the existing carpet by unraveling the edge of the scrap. Prepare the area to be repaired with a thin coat of latex adhesive and install individual tufts, doubled, into the carpet backing using a tuft-setting tool. The tufts should be installed from the edge or corner of the repair and as close together as possible. Trimming or gentle pulling of the tufts will provide a smooth surface.

b. Plug Method. Larger repairs or repairs involving damage to the backing may require the removal of a portion of the carpet and replacement with a matching plug. A piece of matching carpet should be placed over the affected area and aligned to insure that the pattern and direction matches exactly. The carpet may be temporarily tacked in place while cutting. Using a sheet-metal disk plug or metal straightedge, cut both layers of carpet being careful not to fray the edges or damage tufts. Avoid cutting into the carpet padding. Replace the damaged area with the new plug to insure a proper fit. Seams should be taped with 4-inch-wide carpet seaming tape as recommended by the carpet manufacturer. The tape should be bonded with carpet seam adhesive. Insert the patch insuring a proper fit and allow the area to dry, undisturbed, for a minimum of 6 hours.

6.12.2 Replacement

If carpeting is to be removed and replaced, the floor should be inspected and prepared by removing and replacing deteriorated or loose underlayment or subflooring. Large cracks in concrete floors should be repaired as outlined in paragraph 6.3.9.6.

6.12.2.1 *General Installation.* Install carpeting after other finishing operations, e.g., painting, have been completed. Room humidity and temperature must be within limits recommended by the manufacturer and no less than 60° F (15.6° C), for 24 hours before and after installation. Planning for the replacement should minimize the number of seams with no seams occurring perpendicular at doorways.

6.12.2.2 *Installing Carpet Guards.* Carpet guards should be installed wherever the edge of carpet is exposed to traffic. This should be precut to the exact dimensions of all openings except where another device, such as expansion joint cover systems or thresholds, are located with an integral carpet binding bar.

6.12.2.3 *Installing Tackless Carpet Stripping.* Standard tackless carpet stripping should be installed around the perimeter of the room at a distance of not more than ¼ inch from the wall base.

6.12.2.4 *Installing Carpet Cushion.* Carpet cushion is usually laid with the slip-resistant face down; however, check with the cushion manufacturer for the recommended method. The cushion should be cut approximately 6 inches longer than required to butt to the tackless strip and trimmed in place after it is secured. The cushion may be secured using tacks spaced 6 inches apart around all edges, taped with 4-inch-wide tape as recommended by the manufacturer, or spot cementing to the subfloor. All seams should butt tightly and run in the opposite direction of any carpet seams. NOTE: In large rooms or when excess shifting of carpet is anticipated during installation, the carpet may be laid out in the room prior to installing the cushion and turned back to allow installation of the cushion. Once the cushion is secured in place it should be trimmed to butt with the tackless strips and edge guards.

6.12.2.5 *Installing Carpet.* Carpet is cut not less than 3 inches larger than the net room size. Installation begins in one corner of the room away from openings. Stretching the carpet onto the tackless strip is done with a knee kicker or power stretcher which have been adjusted to insure that the teeth

do not become exposed through the backing of the carpet. To start the installation, the carpet should overlap the walls approximately 1½ inches in the starting corner. The carpet should be kicked onto the tackles strips and trimmed 6 inches in each direction from the corner. The carpet should be kicked onto the tackles strips for up to 3 feet from the corner angling the kicker slightly away from the corner.

6.12.2.6 *Length Stretch.* With the beginning corner set, the carpet should be stretched in length by installing the second corner. This should be the corner farthest from the beginning along an adjacent wall, not opposite. The length stretch should use a power stretcher with a head placed three inches from wall. The carpet is held on the tackles strip with a spreader which is released slowly to allow the carpet to hook onto the strip. A kicker is then used to install the corner in the same way as the beginning corner and the entire starting wall between the two corners.

6.12.2.7 *Width Stretch.* The width stretch is performed in the center of the wall opposite the two corners previously installed. The carpet is secured to the strips in the same manner as the length stretch. Instead of using a kicker, the power stretcher is used to secure the entire half of the wall beginning at the point of stretch halfway toward one corner and then the other. The base of the power stretcher should not move during the width stretch installation.

6.12.2.8 *Completing the Stretch.* The installation should continue along the wall opposite the beginning wall using the power stretcher with no angle to the tubes. This is followed by both end walls, also using the power stretcher in a straight stretch.

6.12.2.9 *Cutting.* Excess carpeting along walls should be trimmed with a trimmer or sharp utility knife with approximately ¼-inch excess. The excess is then pressed into the gully between the tackles strip and the wall.